

MONTHLY NOTICES
OF THE
ROYAL ASTRONOMICAL SOCIETY.

VOL. XXVIII.

May 8, 1868.

No. 7.

Admiral MANNERS, President, in the Chair.

Isaac Patchett, Esq., Birstall Academy, Leeds,
was balloted for and duly elected a Fellow of the Society.

Occultations visible in the Month of August, 1868, at Madras, and along the Shadow Path of the Total Eclipse of the Sun in India. By C. Ragoonatha Chary, First Assistant at the Madras Observatory.

(Communicated by N. R. Pogson, Government Astronomer at Madras.)

In consideration of the importance attached to the coming great Solar Eclipse of August next in the Indian Peninsula, and of the interest evinced by Her Majesty's Government and by scientific Societies to secure observations calculated to throw light upon the physical constitution of the Sun, I have taken the liberty of communicating the prediction of certain occultations which will, I trust, be deemed worthy of insertion in the *Monthly Notices* of the Society.

It may not be out of place here to mention that approximate calculations for twelve stations on the central line have been made by me, and that two maps, showing respectively the track of the Moon's shadow across India, and the positions of such stars and planets as will most probably be visible to the naked eye, have been prepared in conformity therewith. My results, together with a popular description of the usual phenomena of a total eclipse by N. R. Pogson, Esq., Government Astronomer, have

been published in the Madras Almanac of the Male Asylum Press, and seven spare copies of the same, in pamphlet form, are herewith forwarded for distribution, and review in the *R. A. S. Monthly Notices*.

As it is intended that several competent observers shall be stationed in different localities along the central line in the Indian Peninsula to secure noteworthy observations of this great phenomenon, and as it is also probable that these observers may have to remain in their places some days prior and subsequent to the date of the occurrence of the eclipse, to ascertain their geographical positions, &c., it occurred to me that, by means of corresponding observations of the occultations of stars by the Moon at the Madras Observatory, as well as at the different places in the track of the shadow at which the eclipse may have been recorded, the terrestrial longitudes of such stations might be pretty accurately determined.

In the hope that such preliminary calculations may prove useful, I have selected such stars only as can be easily observed; and these, twelve in number, will suffer occultation in the month of August, and will be equally visible at Madras and throughout the shadow line. The times of disappearance, reappearance, and the points of contact for these stars, are computed for three equidistant places on the centre line; one on the western coast near Viziadroog, another in the middle near Muktull, and the third on the eastern coast near Masulipatam. As the shadow crosses India nearly along the same parallel of latitude, the variations in time, &c., for the intermediate stations will only be affected by the difference of longitude, and such variations I have therefore given, both for disappearance and reappearance, for each occultation computed. They will enable observers to ascertain easily and approximately the times and points of contact for all intermediate stations.

The tabulated results have been obtained exclusively by the aid of the slide-rule. They are not likely to be uncertain by more than half a minute in time, or a degree in the angular points of contact.

For the Madras Observatory.

1858.	Star's Name.	Mag.	Disappearance.			Reappearance.		
			Local Mean Time. h. m.	Angle from North Point. °	Angle from Vertex. °	Local Mean Time. h. m.	Angle from North Point. °	Angle from Vertex. °
Aug. 2	7043 B.A.C.	6½	13 58·8	110 E	58 L	15 4·8	151 W	146 L
3	29 Capricorni	5	12 4·8	48 E	54 L	13 44·0	94 W	132 R
4	38 Aquarii e ²	6	17 37·9	69 E	3 R	18 43·3	114 W	171 L
10	μ Ceti	4	11 17·4	78 E	156 L	12 16·0	121 W	42 R
12	1406 B.A.C.	7	12 38·1*	78 E	154 L	13 32·5	112 W	33 R
12	Aldebaran	1	13 37·3	71 E	150 L	14 38·6	108 W	25 R
14	12599 Lalande	8	14 18·3*	65 E	140 L	15 8·4	82 W	3 R
14	12650 Lalande	8	14 58·3	38 E	116 L	15 37·9	56 W	25 L

1868.	Mag.	Disappearance.			Reappearance.			
		Local Mean Time.	Angle from North Point.	Angle from Vertex.	Local Mean Time.	Angle from North Point.	Angle from Vertex.	
		^h ^m	[°]		^h ^m	[°]		
Aug. 19	21487 Lalande	7½	7 10.3	163 E	86 L	7 41.2*	123 W	161 L
22	{ xiii. 1016 Weisse's Bessel }	8	9 34.6	65 E	11 R	10 17.9*	35 W	113 R
23	ξ Libræ	6	7 20.7	128 E	68 L	8 34.9	94 W	163 R
25	5579 B.A.C.	5	8 46.3	151 E	98 L	9 38.0	137 W	161 L

* Star below the horizon.

For East Longitude 73° 30' and North Latitude 16° 35'.

1868.	Star's Name.	Mag.	Disappearance.			Reappearance.		
			Local Mean Time.	Angle from North Point.	Angle from Vertex.	Local Mean Time.	Angle from North Point.	Angle from Vertex.
			^h ^m	[°]		^h ^m	[°]	
Aug. 2	7043 B.A.C.	6½	13 9.1	86 E	49 L	14 37.9	126 W	179 L
3	29 Capricorni	5	11 30.5	28 E	48 L	12 50.2	69 W	82 R
4	38 Aquarii e ²	6	17 9.5	48 E	17 R	18 15.0	95 W	166 R
10	μ Ceti	4	10 55.0	65 E	137 L	11 52.3	106 W	31 R
12	1406 B.A.C.	7	12 16.1	63 E	134 L	13 7.8	95 W	21 R
12	Aldebaran	1	13 15.3	53 E	127 L	14 10.0	88 W	10 R
14	12599 Lalande	8	13 59.7	45 E	115 L	14 36.8	61 W	13 L
14	12650 Lalande	8	14 50.7	5 W	69 L	14 54.4	13 W	63 L
19	21487 Lalande	7½	6 36.3	154 E	79 L	7 16.8	111 W	176 L
22	{ xiii. 1016 Weisse's Bessel }	8	9 10.3	45 E	27 R	9 39.6	13 W	87 R
23	ξ Libræ	6	6 33.6	122 E	75 L	7 56.4	83 W	144 R
25	5579 B.A.C.	5	7 49.9	136 E	100 L	9 6.3	118 W	172 R

For East Longitude 77° 20' and North Latitude 16° 25'.

1868.	Star's Name.	Mag.	Disappearance.			Reappearance.		
			Local Mean Time.	Angle from North Point.	Angle from Vertex.	Local Mean Time.	Angle from North Point.	Angle from Vertex.
			^h ^m	[°]		^h ^m	[°]	
Aug. 2	7043 B.A.C.	6½	13 35.4	92 E	48 L	14 56.5	133 W	169 L
3	29 Capricorni	5	11 54.4	33 E	43 L	13 20.9	77 W	104 R
4	38 Aquarii e ²	6	17 27.2	53 E	14 R	18 31.7	99 W	171 R
10	μ Ceti	4	11 9.3	67 E	141 L	12 8.2	110 W	34 R
12	1406 B.A.C.	7	12 29.9	66 E	138 L	13 23.5	99 W	24 R
12	Aldebaran	1	13 29.7	57 E	133 L	14 28.0	93 W	14 R
14	12599 Lalande	8	14 12.2	50 E	122 L	14 54.9	67 W	8 L
14	12650 Lalande	8	14 57.6	13 E	88 L	15 18.0	31 W	46 L
19	21487 Lalande	7½	6 51.3	151 E	77 L	7 31.7	110 W	177 L
22	{ xiii. 1016 Weisse's Bessel }	8	9 25.8	48 E	25 R	9 56.7	16 W	90 R
23	ξ Libræ	6	6 56.9	119 E	67 L	8 17.2	83 W	147 R
25	5579 B.A.C.	5	8 15.6	136 E	93 L	9 27.1	121 W	178 R

For East Longitude $81^{\circ} 10'$ and North Latitude $16^{\circ} 15'$.

1868.	Star's Name.	Mag.	Disappearance.			Reappearance.		
			Local	Angle	Angle	Local	Angle	Angle
			Mean Time. h m	from North Point. °	from Vertex. °	Mean Time. h m	from North Point. °	from Vertex. °
Aug. 2	7043 B.A.C.	$6\frac{1}{2}$	14 0'7	100° E	51° L	15 14'0	140° W	159° L
3	29 Capricorni	5	12 18'4	39° E	39° L	13 50'3	86° W	122° R
4	38 Aquarii e^2	6	17 44'2	58° E	10° R	18 47'4	103° W	176° R
10	μ Ceti	4	11 24'0	70° E	144° L	12 24'3	113° W	37° R
12	1406 B.A.C.	7	12 43'8	69° E	142° L	13 39'5	101° W	25° R
12	Aldebaran	1	13 44'8	62° E	139° L	14 46'1	99° W	19° R
14	12599 Lalande	8	14 25'2	55° E	127° L	15 11'6	72° W	4° L
14	12650 Lalande	8	15 9'1	23° E	99° L	15 38'4	41° W	36° L
19	21487 Lalande	$7\frac{1}{2}$	7 6'0	148° E	74° L	7 46'6	108° W	179° L
22	{ xiii. 1016 Weisse's Bessel }	8	9 40'8	50° E	23° R	10 13'5	20° W	94° R
23	ξ Libræ	6	7 20'3	118° E	61° L	8 37'6	84° W	150° R
25	5579 B.A.C.	5	8 41'8	137° E	88° L	9 47'7	125° W	176° L

Variations for one Degree of East Longitude, to obtain the times and points of contact in the neighbourhood of the three above-mentioned Geographical Positions.

1868.	Star's Name.	Mag.	For Disappearance.			For Reappearance.		
			Time.	N.P. Angle.	Ver. Angle.	Time.	N.P. Angle.	Ver. Angle.
			m	°	°	m	°	°
Aug. 2	7043 B.A.C.	$6\frac{1}{2}$	+6'7	1'8 E	0'3 L	+4'7	1'8 W	2'6 R
3	29 Capricorni	5	+6'3	1'5 E	1'2 R	+7'8	2'2 W	5'2 R
4	38 Aquarii e^2	6	+4'5	1'3 E	0'9 L	+4'2	1'0 W	1'3 R
10	μ Ceti	4	+3'8	0'7 E	0'9 L	+4'2	0'9 W	0'7 R
12	1406 B.A.C.	7	+3'6	0'8 E	1'1 L	+4'1	0'8 W	0'5 R
12	Aldebaran	1	+3'9	1'3 E	1'6 L	+4'7	1'5 W	1'2 R
14	12599 Lalande	8	+3'3	1'2 E	1'6 L	+4'5	1'4 W	1'1 R
14	12650 Lalande	8	+2'4	3'6 E	3'9 L	+5'7	3'7 W	3'4 R
19	21487 Lalande	$7\frac{1}{2}$	+3'9	0'7 W	0'6 R	+3'9	0'3 E	0'5 L
22	{ xiii. 1016 Weisse's Bessel }	8	+4'0	0'6 E	0'5 L	+4'4	0'9 W	0'9 R
23	ξ Libræ	6	+6'1	0'5 W	1'8 R	+5'4	0'1 W	0'8 R
25	5579 B.A.C.	5	+6'8	0'2 E	1'6 R	+5'4	0'8 W	1'6 R

A Catalogue of Spectra of Red Stars. By Father A. Secchi.

In a letter addressed to Admiral Manners, President of the Society, Father Secchi writes:—

“I send you, according to my last letter, a part of the Catalogue

of Red Stars, examined with the spectroscope. Its construction has been improved by using only cylindrical lenses for the eyepiece, which has been made by M. Merz, and works admirably well. You will see that there is a new type of stars (the fourth) which is described in my Memoir in the *Soc. Italiana*, plate ii. fig. 7. I have already found several of that kind, so that it deserves to be characterised as a particular type. This classification is very curious indeed. I am, however, surprised to see some zones always at the same places; so that there is a great cosmical law which is about to come forth; but, for the present, we must wait until the review of all the stars has been accomplished. You see, however, that the red stars make quite a family by themselves, which is very distinct.

"I have examined (yesterday) the spectrum of Brorsen's Comet, although it was a little hazy and low. I have found it discontinuous, with a very bright and large zone in the green, and two narrower, but bright, also in the yellow and red, and a sufficiently strong zone in the blue. I hope to be able to send a drawing of it, but I must wait for better sky.

"Rome, April 23, 1868."

A Catalogue of Spectra of Red Stars.

The Numbers are those of the Catalogue of M. Schejellerup, published in the *Astr. Nach.*, and in Mr. Chambers' *Astronomy*. The position is his own, without further correction. In explanation of the description, I say that 1st type is *Sirius* or α *Lyræ*; 2d type of yellow stars is *Pollux* and the Sun; the 3d type is α *Orionis*, α *Herculis*; the fourth type is *Lal.* H. C. No. 12561, described in my memoir printed in the *Soc. Italiana*. In a second communication I will give the rest, since some want verification, although they have been observed. The indication *figured* is relative to the figures (coloured) which are at the Observatory. I have used the word *column* to indicate the large divisions in shape of pillars, which is characteristic to the third type in α *Herculis*, &c.

No. of Schej.	R. A.		Decl.	Mag.	Description and Colour (Sp. = Spectrum.)
	h	m			
11	1	20.6	-33 17	6	Rose; sp. discontinuous, with zones.
12	1	23.4	+ 2 9	v. 8	Pale red; nothing particular.
16	1	59.0	+ 0 46	var.	Red; very weak.
17	2	8.1	+24 24	var.	Very rich yellow in the spectrum.
19	2	12.3	- 3 37	var.	In the max. of 3d mag. This star now has
α Ceti					a sp. like α <i>Orionis</i> and β <i>Pegasi</i> , but with sharper lines, and resolved in more black field. Very fine object.
Algol	2	59.8	+40 27	v. 4	Type of α <i>Lyræ</i> even in the minimum.

No. of Schej.	R.A. h m	Decl. ° ' "	Mag.	Description and Colour (Sp. = Spectrum.)
23	2 34.8	+31 50	neb.	Weak sp. with zones.
26	3 9.4	- 6 14	7	Yellow; sp. continuous.
33	4 13.7	- 6 3	7.7	Sp. cont.; near it is another * with zones.
34	4 14.2	+20 29	6	Pale red; sp. striated, but without zones.
36	4 20.6	+ 9 51	7½	Yellow orange; sp. with light zones.
38	4 26.7	-11 5	6.7	Yellow red; sp. striated, without zones.
39 Tauri	4 27.9	+16 13	1	Very red colour, and its spectrum shows not only lines, but even traces of zone, and columns. It was not so last year when the star was not so red. In the green are the four characteristic lines of α Orionis.
41	4 36.7	+67 55	6½	A superb object; a spectrum of the 4th type, divided in three columns, yellow, green, blue; figured.
43	4 42.7	+28 17	8	Pale red; sp. with 3 zones, as the preceding one; 4th type.
44	4 44.6	+14 1	5	Magnificent object; it is completely resolvable in columns and lines, like α Orionis.
45	4 46.5	+ 2 15	5½	Pale rose; lines very distinct, without columns.
46	4 48.2	+ 7 33	7	Pale; lines of the 3d type.
48	4 51.4	7 55	var.	Yellow golden; uniform sp.
49	4 53.?	-15 1	var.	Spectrum uniform.
50	4 54.6	+ 0 31	6	Spectrum uniform.
51	4 58.2	+ 0 59	6½	Vivid red; sp. made of three bundles of zones; red and yellow very vivid; green very large; violet; figured.
54	5 10.4	+39 11	7	Weak, with lines; feeble.
58	5 22.6	- 1 12	5	Gold yellow, deep; strong magnesium line; spectrum almost uniform in the rest; type of the yellow stars.
59	5 24.1	+18 29	5½	Magnificent object, exactly like α Orionis; completely resolvable into lines; it is α Orionis in miniature; orange red.
60	5 29.3	10 57	7½	Spectrum with bands in the green.
63	5 35	+ 2 18	7.7	Small; nothing particular.
66 α Orionis	5 47.6	+ 7 23	1 var.	This star is more red this year than the last; the spectrum is divided into columns, but the striæ do not correspond in the red with the shades of the columns. The lines of the hydrogen are very visible. In the green the lines are very distinct. A new figure made, which agrees with that of the preceding years.
67	5 49.6	+45 55	5	Gold yellow; very fine star; the spectrum is completely resolvable, like σ Ceti; splendid object.

No. of Schej.	R.A.	Decl.	Mag.	Description and Colour (Sp. = Spectrum.)
78	^h 6 ^m 26.9	^o +38 ['] 33	6½	Star described in the <i>Mem. della Soc. Italiana</i> . This makes the 4th type, which consists in 3 large coloured zones of double extent of those of the 3d type. Magnesium very strong; vivid yellow, green, and blue; very curious thing!
83	6 49.9	70 56	6	Yellow; sp. uniform.
85	6 56.2	-27 44	3½	Yellow type; very fine striæ, with magnificent red, and strong black line in the green (magnesium).
87	6 58.9	22 55	var.	Small; nothing interesting.
89	7 1.5	-11 43	7½	Spectrum of the 4th type, but the middle black zone is narrower.
90	7 6.5	+59 10	7	Yellow; nothing particular.
91	7 7.2	+22 12	7.3	<i>Rufa</i> ; weak; nothing singular.
96	7 34.6	+29 33	5	Yellow; sp. fine lines.
107	8 18.1	-37 50	6	Too low; nothing particular.
117	8 48.7	+20 23	var.	Small; nothing particular.
119	9 1.9	-25 17	4½	Gold yellow; strong line <i>b</i> , and vestiges of zones.
120	9 2.2	+31 32	6	Perfectly of the type of α Orionis, but in the interval of the columns the spaces are perfectly black, so that it gave a most discontinuous spectrum; very curious. In the green it is resolvable.
123	9 40.1	+12 5	var.	Small; sp. discontinuous, but very difficult.
Nobis.	9 16.7	-21 42	6½	Very fine yellow type of α Orionis; very neat, although small.
124	9 44.6	-22 22	6½	Type 4th, but the blue is very weak, so that there remain only the yellow, the red, and the green, separated by a very black interval.
127	10 4.0	-7 44	6	Orange red; vestiges of weak zones. It is preceded by one of the 1st type.
128	10 5.8	-34 38	7	With very large zones and very neat; one very large in the green; it seems of the 4th type.
132	10 30.7	-12 39		Of the 4th type, very neat and luminous; it has two bright zones in the yellow, a very fine green and weak blue, separated by intervals. Figured. Colour, orange yellow.
136	10 44.8	-20 30	6½	4th type of spectrum, but reduced to the yellow and green; the rest is too weak.
137	10 52.6	-15 36	6	Clear red; type of α Orionis; well striated, but weak zones.
138	10 53.7	-17 34	8	Small, and nothing interesting.
141	11 10.9	33 52	4½	Gold yellow; the spectrum is like Capella, with fine lines; the lines <i>F</i> and <i>b</i> are very neat.

No. of Schej.	R.A.		Decl.	Mag.	Description and Colour (Sp. = Spectrum.)
	h	m			
152	12	38.5	+46° 13'	5½	A most beautiful object; the spectrum is exactly of the fourth type. The luminous zones are exceedingly vivid, and make a curious contrast with the black interruptions. There are some very strong vivid zones in the yellow and in the blue. Figured. Very singular, indeed. The colour is a vivid ruby red.

On the Variability of η Argûs and Surrounding Nebula.

By F. Abbott, Esq.

The communications on the variability of η Argûs and the surrounding Nebula, which I had the honour of submitting to the Society, have led to the expectation of some continued observations on the light and character of both these objects.

The singularity of the nebulous portion of this region has but recently been made a subject for systematic examination, and but for the observations and beautiful monograph of Sir John Herschel, the peculiarities attached to it might have remained unknown for a long time to come.

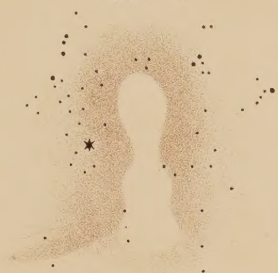
In 1677 the star η was recorded by Halley as of the 4th magnitude. Its maximum was first noted by Burchell in 1827, it being then of the 1st magnitude; and on the 30th March, 1863, it was found for the first time reduced to the 6th magnitude. Independent, however, of the variability of the star itself, there is a much more singular property belonging to the surrounding Nebula, the particular features of which I now purpose to describe.

The mutability of the Nebula will be best made apparent by the accompanying drawing (see Plate), which will at once show the different forms of the dark space, and the relative position of η Argûs to it, from 1834-7 to 1868.

It must not be considered, however, that the position and character here given are the only ones in which the object has appeared; a system of photographs only would be the means of assisting materially the recognition of a principle of irregularity pervading the whole structure.

The missing portion of the nebulous matter, as compared with the Cape monograph, may be thought by some to be owing to the want of a larger optical power, but when the same instruments have been used throughout, this objection as to variability must fail to have any weight. The principal instrument used is a 5-feet Equatoreal by Dallmeyer. The building being situated in a garden, the view of a small portion of the circumpolar stars is intercepted by fruit-trees: to make good this want, a 5-feet portable refractor by Varley is used in the open air, so that the

η ARGUS AS SITUATED TO THE DARK SPACE,
 VARIABILITY OF THE SURROUNDING NEBULÆ,
 WITH THE MAGNITUDE AND POSITION OF ACCOMPANYING STARS.
 1834-7.

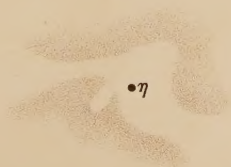


1868



$1^{\circ}.07'.47''$

1863



FROM THE YEAR 1834 TO FEBRUARY 13TH, 1868.
 TAKEN AT INTERVALS.

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object has been watched and noted throughout its entire revolutions round the Pole.

The eye-pieces in general use, and found most suitable for this purpose, are a Comet one of 28, an Orthoscopic of 45, and an Annular Micrometer of about the same power. A more powerful instrument would, no doubt, at any one observation, alter the apparent features of the Nebula, and render manifest changes of a somewhat different character to those here described. To witness these effects I wait the arrival of the Melbourne telescope, when I hope to have the opportunity of more correctly verifying these statements.

The investigation of the fluctuations connected with the object η Argûs appears not to require such refined and delicate observations as were bestowed on Herschel's sub-nebulous region near the trapezone in *Orion*, by the late Professor Bond and Earl of Rosse; nor are such powerful instruments necessary.

Take, for instance, the position of the star η , as given by Sir J. Herschel at the Cape of Good Hope, and note its position again when in the darker space, as confirmed by E. B. Powell, Esq., at Madras, and now for the third time compare its situation, removed from the dark space altogether to quite a different portion of the Nebula, and it will appear clear that the optical means employed have been ample, notwithstanding Mr. Powell was at first inclined to think that the fluctuations were only apparent, and owing to the inferiority of his instrument.

The beautiful, soft, white light given out by the nebulous matter about η Argûs appears to be produced, either from the increased magnitude of the stars, or the displacement of some of the nebulous mass, or probably from both, for in the former case it is difficult to say (only from its position) which is η Argûs, and which is not, there being so great a similarity in its size and that of some of the accompanying stars. On a clear, fine night, the object gives out fully twice as much light as that of the Great Nebula—Nebicula Major, and about three times as much as Nebicula Minor, irrespective of size. In the twilight it appears as soon as a star of the second or third magnitude, the light being white and more diffuse, very like a small white woolly cloud on a blue sky, seen in Sunlight.

At present there appears to be no further diminution in the magnitude of the star below the 6th. Being in Melbourne on the night of the 25th March, 1865, which was a very fine one, and happening to look towards η Argûs, I fancied that the star appeared as a distinct point in the Nebula. I immediately proceeded to the Observatory, Mr. Ellery, with his accustomed kindness, allowing me to take possession of the Equatoreal; and on examining the object, found the colour of the small accompanying stars to be the same as before described, and, with the comparative eye-piece, considered the star to be 5.5. It was about this time that Mr. Tebbutt, of New South Wales, forwarded the result of his observations to the Society, giving the star as

5.5. This appearance, however, must be considered only transitory, for many times since that period the star has not reached more than the 6th magnitude, and may be so estimated at present.

The accompanying drawing was made with an inverting eyepiece, and taken 75° East of the Meridian, to prevent the unpleasantness of taking it near the zenith. If, therefore, the line of sight is brought to correspond with the South of the Cape Monograph, the position of both drawings will be made approximately to agree at the time they were taken.

*Private Observatory, Hobart Town, Tasmania,
February 29, 1868.*

Questions relative to the Original Inventor of the Achromatic Telescope. By A. D. Wackerbarth, Director of the Observatory of Upsala.

The invention of the Achromatic Telescope is one of such immense importance, that all facts and all persons in any way connected with its history assume a character of the most lively interest to those engaged in the cultivation of physical or astronomical science; one naturally desires to know as much as possible about them. Now we find in Grant's *History of Physical Astronomy*, p. 353, and in Hutton's *Mathematical Dictionary* (edit. 1796), vol. i. p. 26, as also in Barlow's *Optics* (*Encyclop. Metrop.* vol. iii. p. 408), that the man who really first invented this beautiful instrument was Chester More Hall, Esq., of More Hall, in the county of Essex, who not only discovered the secret of achromatism, but even constructed several achromatic telescopes as early as 1733. The two first of these writers quote, as the source of their information, the *Gentleman's Magazine* for 1790, part ii. p. 890. Sir John Herschel, in his noble essay on "Light" (*Encyclop. Metrop.* vol. iv. p. 411), calls Mr. Hall "a gentleman of Worcestershire," not Essex. I have in vain searched a map of Essex for this gentleman's residence, More Hall, and I have also searched the descriptions, both of Essex and Worcestershire, in the *Beauties of England and Wales*, as the collectors for that voluminous work generally give some biographical account of the worthies connected with the places they describe; but I have searched in vain, as I do not find that they mention any such place as More Hall in either of the above-named counties. The *Gentleman's Magazine* is not accessible to me here (at Upsala). One circumstance that renders Mr. Hall and his telescopes especially interesting is that, according to both Hutton's and Grant's citations from the *Gentleman's Magazine*, Mr. Hall, "about 1733, completed several achromatic telescopes (though he did not give them this name) *that bore an aperture of more than $2\frac{1}{2}$ inches, though the focal length did not exceed 20*

inches, one of which is now [*i.e.* 1790] in the possession of the Rev. Mr. Smith, of Charlotte Street, Rathbone Place." It appears, then, that Mr. Hall's lenses must have been of a very good quality, for the length of his telescopes was only eight times their aperture, whereas an instrument by Dollond, preserved in this Observatory, with an aperture of four inches, has a length of ten feet, or thirty times the aperture; and even on the scale of Steinheil's telescopes (probably the most perfect yet constructed) an aperture of $2\frac{1}{2}$ inches ordinarily requires a focal length of thirty inches, or twelve times the aperture, that is, half as much again as Mr. Hall's. The length of instruments, even of the Herschel-Gauss construction, executed by Steinheil, is said to be ten times the aperture.

Mr. Hall's custom was, to have his lenses ground by ordinary workmen, but he himself put the finishing hand to the work, bringing up the surfaces to the exact curvature requisite "to correct not only the different refrangibility of rays, but also the aberration arising from the spherical figure of the lenses," so that both chromatic and spherical aberration were eliminated. It seems almost unaccountable that an invention so brilliant and so ably carried out should have fallen, and that in so short a time as thirty years, into oblivion, especially as Mr. Hall does not appear to have made any secret of it. For "old Mr. Bass, who at that time lived in Bridewell precinct, was one of those working opticians [namely, who ground lenses for Mr. Hall], from whom Mr. Hall's invention was obtained." As the invention was obtained (it is not said by whom) from Mr. Bass, it is clear that Mr. Hall must have communicated it to Mr. Bass, and he probably thought that this would be sufficient to perpetuate it, for, as he "was a gentleman of property, who did not look for any pecuniary advantages from his discovery," he no doubt supposed that, in communicating it to an artificer and tradesman, he had done sufficient to insure for ever to the public the benefit of it; but unfortunately, for his own fame, he made no legal publication of it. Who the persons were who opposed Dollond's claim to a patent, I know not, though no doubt the minutes of the trial in Westminster Hall before Lord Mansfield would inform us; but, as they produced on that occasion one of Mr. Hall's instruments as evidence of the art being already known, I take for granted that they were tradesmen, opticians, who had received the knowledge of Mr. Hall's invention from Mr. Bass. Hutton's citation from the *Gentleman's Magazine* concluded thus: "That Mr. Ayscough, optician on Ludgate Hill, was in possession of one of Mr. Hall's achromatic telescopes in 1754, is a fact, which at this time [1790] will not be disputed." This, I take it, was the instrument which Mr. Barlow says was on sale that year. But both Sir John Herschel and Mr. Barlow state (*locis citatis*) that, when they wrote, *i.e.* A.D. 1827, some of Mr. Hall's telescopes were still in existence. I conceive it therefore to be highly probable that some of them are even now to be found, and if so, it would

be in the highest degree interesting if any one having access to one of them would give an accurate and detailed description of it. Mr. Hall was evidently a man of no ordinary capacity and perseverance, and all that can be learned about him would doubtless be instructive and interesting. It would be desirable to know what sort of lenses he used, of what kind of glass, how they were disposed, and whether their number was two or more, what sort of eye-pieces the instrument was furnished with, &c., &c. Such information cannot be too highly prized.

Uppsala, April 16, 1868.

(From the "*Gentleman's Magazine*," 1790, part ii. p. 890.)

"The writer of an Introduction to some Letters lately published, on the Improvement of Ship-building, seems to have been misled in saying, 'that great discovery in optics, the achromatic glasses, was entirely owing to three or four ingenious men assembling at a public-house in Spitalfields, to amuse themselves in friendly conversation upon mathematical and mechanical subjects.'

"As the invention has been claimed by M. Euler, M. Klingstierna, and some other foreigners, we ought, for the honour of England, to assert our right, and give the merit of the discovery to whom it is due; and therefore, without further preface, I shall inform the author of the above quotation that the inventor was Chester More Hall, Esq., of More Hall, in Essex, who, about 1729, as appears by his papers, considering the different humours of the eye, imagined they were placed so as to correct the different refrangibility of light. He then conceived that if he could find substances having such properties as he supposed these humours might possess, he should be enabled to construct an object-glass that would show objects colourless. After many experiments he had the good fortune to find these properties in two different sorts of glass; and by forming lenses made with such glass, and making them disperse the rays of light in contrary directions, he succeeded. About 1733 he completed several achromatic object-glasses (though he did not give them this name) that bore an aperture of more than $2\frac{1}{2}$ inches, though the focal length did not exceed 20 inches; one of which is now in the possession of the Rev. Mr. Smith, of Charlotte Street, Rathbone Place. This glass has been examined by several gentlemen of eminence and scientific abilities, and found to possess the properties of the present achromatic glasses.

"Mr. Hall used to employ the working opticians to grind his lenses: at the same time he furnished them with the radii of the surface, not only to correct the different refrangibility of rays, but also the aberration arising from the spherical figures of lenses. Old Mr. Bass, who at that time lived in Bridewell precinct, was

one of those working opticians, from whom Mr. Hall's invention seems to have been obtained.

"In the trial at Westminster Hall about the patent for making achromatic telescopes, Mr. Hall was allowed to be the inventor; but Lord Mansfield observed, that 'it was not the person who locked up his invention in his *scrutoire* that ought to profit by a patent for such invention, but he who brought it forth for the benefit of the public.' This, perhaps, might be said with some degree of justice, as Mr. Hall was a gentleman of property, and did not look to any pecuniary advantage from his discovery; and, consequently, it is very probable that he might not have an intention to make it generally known at that time.

"That Mr. Ayscough, optician on Ludgate Hill, was in possession of one of Mr. Hall's achromatic telescopes in 1754, is a fact which at this time will not be disputed.

"VERITAS."

Remarks on the Name of the Star ξ Scorpii (= Fl. 51 Libræ).

By A. Brothers, Esq.

In a note to the reprint of my list of Binary Stars, which appeared in the last Number of the Society's proceedings, Mr. Chambers calls attention to the fact that I, at the suggestion of the late Rev. W. R. Dawes, had designated the star 51 Libræ " ξ Scorpii," as also did Smyth, "but in retaining the appellation "51 Libræ" he (Mr. Chambers) "had followed the better supported usage."

The reason for the proposed alteration will be found in the following quotation from a letter received from Mr. Dawes in Sept. 1866, in which he says, "I should really be glad if you would assist in restoring this star to *Scorpio*, from which it was taken by a mere blunder of Flamsteed's, as is generally acknowledged. Why then do not astronomers generally follow the course of that most accurate of all star-catalogue and star-map authors, Argelander, and erase this star from *Libra* (which has already three other ξ 's, and restore it to *Scorpio*, which, without this, has no ξ at all? The best way, perhaps, to write the name would be ' ξ Scorpii (= Fl. 51 Libræ).' To continue perpetuating Flamsteed's acknowledged blunder seems to me nothing less than absurd." This, to me, was quite sufficient to authorise the change suggested, and I had no hesitation in following the advice of one so thoroughly competent to give it. Mr. Dawes named the star in his own Catalogue in the same manner.

A copy of the list of binaries, as it is printed in Mr. Chambers' book, was forwarded to Mr. Dawes, who on the 21st March, 1867, wrote to me as follows:—"I confess that I cannot help feeling much annoyed that this excellent opportunity of giving your support to the rectification of the blunder about ξ Scorpii

should have been thrown away; or rather, in fact, that, *contrary to your own conviction*, you should have been made to appear a *supporter of the blunder*." The words in italics are so marked by Mr. Dawes.

It will be seen by reference to the Catalogue as published by the Manchester Literary and Philosophical Society, and also in the *Astronomical Register*, that the star is named as Mr. Dawes proposed, and it will, I think, be admitted that the opinion expressed by Mr. Dawes ought to have been respected, unless any good reason could be found for the alteration made by Mr. Chambers.

The reason assigned by Mr. Chambers for publishing a second edition of my list (which is not the *Catalogue*), with the addition of a few objects of the doubtful class, is, that the R.A.'s and Decs. are not brought down to any uniform epoch. The difference of ten years, more or less, appeared to me of no consequence, as the stars could be found just as well whether the places were given for 1860 or 1870; and the places of the whole of the objects excepting those taken from Smyth's *Cycle*, are given for 1860, but the remainder I reduced to 1865; in the latter case the reduction was a matter of necessity, but in the former it was not.

Mr. Chambers remarks, "As there were other defects in it (the list), which it is not worth while to particularise," and refers to his re-computation and re-writing the list as a matter of necessity, owing to the errors he had detected in it. I shall be obliged if Mr. Chambers will point out these errors; for beyond one or two printer's errors I am not aware of the existence of any. If the Catalogue, as published in full, is the one referred to, I know of only one error, and that is the substitution of the name of one observer for another, a matter of very trivial consequence.

In the compilation of a work of this kind very much must depend on the judgment of the compiler. It may be thought by some that γ *Andromedæ* (not γ^2) and one or two other objects ought to have been omitted, but it will be seen by reference to the introduction to the Catalogue, that I have given reasons for inserting them.

On this subject Mr. Dawes wrote to me 13th Oct. 1867: "As to the way in which you have accomplished your rather arduous task, so entirely self-imposed, I assure you that I think you have done it in excellent style, and provided a very useful companion to the observatory for all double-star observers."

As to the *necessity* for such alterations as are introduced by Mr. Chambers, it will be seen by reference to my Catalogue that some of Mr. Dawes's measures are given as late as Dec. 1866 (1866.99), with many others by different observers in the same year; and I am not aware that any information to which Mr. Chambers could refer has been published since the date named, and which could justify him in altering the figures in the list which I prepared for his book.

To quote again from one of Mr. Dawes' letters, in which he says: "It is not by any means easy in some cases to determine, with anything like certainty, what are truly *binary* stars." If Mr. Chambers will go through all the published results and produce a Catalogue differing in any important particulars from the one I have already published, I have no doubt it will be found useful; at the same time I do not think much fresh material to work upon will be found, considering that a large proportion of the most valuable part of my Catalogue was supplied by the observers specially for my work.

Remarks on the Stellar Longitudes assigned by Ptolemy. By W. W. Drayson, Capt. and Major Royal Artillery, Prof. of Surveying, &c. R. M. Academy, Woolwich.

The Star Catalogue of Ptolemy being the earliest of which we have any record, has always possessed great interest to astronomers. It has been most ably arranged by the late Mr. Bailey in vol. xiii. of the *Memoirs*.

An examination of the longitudes of various stars in Ptolemy's Catalogue has revealed a singular fact, which we will express in the words of Mr. Baily. "That Ptolemy was an observer, is I think manifest from his recorded observations of the planets, as well as from other evidence which his incomparable treatise affords. Nevertheless it must be admitted that the positions of the stars in his Catalogue will not agree with the precise epoch that he has stated, but that the longitudes must be increased at least 1° , the latitudes remaining the same." The fact of the longitude being in almost every case 1° too little in the above Catalogue is so well known, that no further reference need be made to this portion of the subject.

In the *Nautical Almanac* for 1822, the longitudes of nine stars are given. By comparing these longitudes with that assigned by Ptolemy we find the following differences in degrees and minutes:—

α Arietis	$24^{\circ} 24'$
Aldebaran	$24^{\circ} 32'$
Pollux	$23^{\circ} 59'$
Regulus	$24^{\circ} 45'$
Spica Virginis	$24^{\circ} 35'$
Antares	$25^{\circ} 30'$
α Aquilæ	$25^{\circ} 19'$
Fomalhaut	$24^{\circ} 15'$
α Pegasi	$24^{\circ} 14'$

The Catalogue of Ptolemy is reduced to the first year of the

reign of Antoninus, which corresponds to A.D. 138. Hence the interval between 138 and 1815 is 1677 years.

Taking the precession in longitude to be $50''\cdot 2$ annually, we ought to find for 1677 years a difference of only about $23^{\circ} 23'$ in the longitudes, instead of nearly $24\frac{1}{2}^{\circ}$.

The conclusion that appears to have been very generally arrived at is, that Ptolemy did not observe, but merely copied from his predecessors; this conclusion the Author thinks is not sound.

As far as the Author is aware, no satisfactory explanation has hitherto been given of the reason for all Ptolemy's longitudes being too little, thus whilst we cannot but admire the ingenuity of this ancient astronomer's method for determining longitudes, we yet perceive his results erroneous and in one direction.

The instruments used by Ptolemy and his contemporaries seem to have been of three kinds; only one of which will be referred to, viz. the Astrolabe, for taking the distances in longitude between the Sun and Moon, and the Moon and a star.

This instrument consisted of two rings fixed at right angles to each other, one in the plane of the ecliptic, the other in that of the solstitial colure. Two other rings were fixed to the instrument so as to form circles of celestial longitude, and turned about an axis, therefore coincident with the poles of the ecliptic.

When an observation was made for longitude, one of the moveable circles was directed to the Sun or Moon, having been first fixed to that degree of the ecliptic circle which expressed the known longitude of the Sun, thus the zero of the graduations was made to agree with the vernal equinox in the heavens.

Then the other moveable circle of longitude was directed to the second body, and the arc of the ecliptic between the zero and moveable circle gave the star's longitude. Considering that Ptolemy had no clocks, we think no more ingenious method than this could be adopted for determining longitudes of stars.

Having now considered the instrument in use, we will next speak of the method which must have been adopted.

In the first place, during *the evening* and earlier portions of the night was the most suitable time for using this instrument, and not after sunrise or during daylight, because the stars were not then visible. This fact being established it would follow that the order of the observations must have been made very much in the following manner:—

The Sun's longitude having been calculated for the day and hour of observation, the first movable circle was directed towards the Sun when near sunset, and thus the zero of longitudes would be fixed. A star not being visible as long as the Sun was above the horizon, the Moon would necessarily be made use of, and her longitude could readily be obtained by measuring the arc on the ecliptic between the Moon and the Sun. Hence the most suitable time for using the astrolabe would be during the first quarter of the Moon.

In the same manner that we determined the Moon's longitude by this instrument, so could we determine the longitude of a star. For by keeping one circle fixed on the Moon, whose motion in longitude was very fairly known by Ptolemy, the other circle being directed to the star, the *difference* in these two bodies' longitudes would be obtained, and hence the longitude of the star could be fixed.

We can now take a simple example of this method.

Suppose the Sun at the instant of observation or of fixing the instrument, to be at the vernal equinox, the Moon on the ecliptic and in quadrature. Hence the Moon's longitude would be 90° , and the angular distance between the Sun and Moon 90° on the sphere. The Moon would be on the meridian at 6 P.M., and would set at midnight. Suppose a star on the ecliptic and 90° from the Moon, this star's longitude would have been obtained by Ptolemy by obtaining its distance from the Moon at any convenient time of night, and finding the arc on the ecliptic marked by his two circles. Having fixed the longitude of any star, this star could be made use of instead of the Sun for obtaining the position in the heavens of the vernal equinox. Thus it is evident that the first start must be best made from fixing the instrument to obtain the zero of longitudes by *the Sun*. Next obtain the Moon's longitude from the Sun and then that of a star.

The Moon might be made use of for fixing the zero of longitudes, but from the irregularities of her movements, it is probable that the Sun was most generally used.

In either case, however, a very considerable error in all longitudes would arise in consequence of Ptolemy not being aware of one item used in Astronomy.

Taking the latitude of Alexandria (where it is supposed Ptolemy made his observations), to be 31° , the Moon when having its greatest north declination, would be only about $2\frac{1}{2}^\circ$ from the zenith. Referring to the example already given, the Moon would then have been within $2\frac{1}{2}^\circ$ of the zenith and the Sun on the horizon. Ptolemy was unacquainted with the effect of refraction, and therefore would assign to the Moon at such a time a longitude or distance from the Sun too little by the amount of the Sun's refraction, which near the horizon would be $30'$. The effect of refraction would be to bring the Moon and Sun *nearer* together, for the Moon being near the zenith, the Sun would be brought nearer thereto by refraction, and hence the Moon's assigned longitude would be less than it ought to be by $30'$.

If after the Moon's longitude had been thus determined by the astrolabe, a star near the eastern horizon were selected, or if Ptolemy waited until a star reached his meridian whilst the Moon had approached the western horizon, another error of nearly $30'$, and in the same direction, would be added to the first, and thus from refraction alone, the star would be given 1° too little longitude.

Although the method here dealt with is that probably used

by Ptolemy, it may be supposed an extreme case, and one giving the greatest amount of error; it is so, but it may be borne in mind that in nearly every case refraction brings celestial bodies nearer together, and *never* causes them to appear further apart than they really are. In fact, when the Sun was on the horizon and the Moon at the zenith, their distance would be lessened by $34'$, whilst if the Moon were on the horizon and a star at the zenith, their angular distance would be lessened by an additional $34'$, making a total of $1^{\circ} 8'$ error in longitude of the star, which $1^{\circ} 8'$ would be too little. Hence a star whose true longitude was 180° would be assigned only $178^{\circ} 52'$.

It seems probable that Ptolemy would select the period of either the vernal or autumnal equinox as the period for determining the longitude of some star, also that he would, to ensure the Moon's longitude being as slightly changed as possible, select the time when the Sun was near the horizon, and thus these conditions, being those best adapted for the working of his astrolabe, would yet give the greatest error from refraction.

To account for all the errors in the Catalogue of Ptolemy is of course impossible, many of these are undoubtedly due to errors of observation and to imperfect instruments. The Author merely endeavours to point out in this paper how it is possible, if not probable, that with such an instrument as the astrolabe an observer unacquainted with refraction would be in error about 1° in all his longitudes, and that this 1° would be shown by omitting that amount from his assigned longitudes, which would therefore in every case be too little, as is the case in Ptolemy's Catalogue.

On a New Driving-Clock for Equatoreals.

By Thos. Cooke, Esq.

One of the great essentials of modern astronomical observation—second only in importance to the perfection of the object-glass or mirror employed—is a perfectly steady, firm, and uniform motion of the instrument under the varying resisting forces to which it is subjected.

By such a motion the fixed micrometer-wire and the (apparently) moving celestial body remain at absolute rest with regard to each other for a large interval of time.

One of the most satisfactory attempts to attain this end was made by the great Fraunhofer in the driving-clock attached to the refractor at Poulkowa. In this arrangement the motion was regulated by the friction of centrifugal balls against the interior of a conical box, the rate of motion being determined by raising or depressing the pivot of the conical pendulum; each change in the position of the pivot changing the degree of friction.

In a modified form this system has for many years been adopted in this country, but I have never been thoroughly satisfied as to its perfect uniformity: indeed, it is very difficult to imagine that a perfectly uniform rotatory motion can ever be attained by such a regulator, whenever changing resistances have to be overcome.

It was, doubtless, this consideration which induced the lamented Professor Bond to adopt his "Spring Governor," in which the regulator took the form of an oscillating pendulum, the intermittent movement being transferred into a uniform one—first, by means of the torsion of a spring fixed lengthwise on the axis of one of the wheels; and secondly, by means of an air-fan. Although the regulation of the spring governor was correct in theory, it failed in practice, owing to the delicate nature of the principle, as soon as varying resistances had to be overcome. In both the systems referred to the motive power was a weight.

In a third arrangement adopted by the Astronomer Royal, water is used as a motive power and regulator; the resultant motion being controlled, in addition, first by a conical pendulum, and secondly, by Siemens' chronometric arrangement.

My attention has lately been specially directed to these various arrangements, as it has become necessary to construct a driving-clock for the Great Refractor. The defects of the two former systems were so strong to my mind, that the arrangement now brought before the notice of the Society was devised to replace them. The regulator adopted in this driving-clock is the vibrating pendulum, because, amongst the means at the mechanician's command for obtaining perfect time-keeping, there is none other by which the same degree of accuracy can be obtained. The difficulty in this construction is the conversion of the jerking or intermittent motion produced by such pendulums into a uniform rotatory motion, which can be available *with little or no disturbing influence on the pendulum itself*, when the machine is subject to varying frictions and forces to be overcome in driving large equatorials. This was the difficulty proposed to be met by Bond's Spring Governor. It is met in the new one by the principles and mechanical arrangements described below.

1. The pendulum is a half-second one, with a heavy bob, adjusted by sliding the suspension through a fixed slit. It is drawn up and let down by a lever and screw, the acting length of the pendulum being thus regulated. The head of this screw is made large and grooved, and holds an endless cord, by which the observer can at once regulate the speed.

2. The scape-wheel is a double one, each wheel having four teeth; the pallets are round steel pins, producing nearly a dead beat, and work between the two scape-wheels. The teeth of one wheel strike one pallet; the teeth of the other wheel on the other pallet. A small amount of recoil is purposely given. The wheel makes one revolution in eight vibrations or in four seconds.

3. The arrangement of the wheels represents something like

the letter U. At the upper end of one branch is the scape-wheel. At the upper end of the other branch is an air-fan. The large driving-wheel and barrel are situated at the bottom or bend. All the wheels are geared together in one continuous train, which consists of eight wheels and as many pinions. The scape-wheel and the two following wheels have an intermittent motion. All the others have a continuous and uniform one.

4. The change from one motion to the other is made at the third wheel, which, instead of having its pivot at the end of the arbor where the wheel is fixed—fixed to the frame like the others—is suspended from above by a long arm having a small motion on a pin fixed to the frame, the pivot at the other end of the arbor is fixed to the frame as the others are, but its hole and its pivot are arranged so as to permit a very small horizontal angular motion round them, as a centre, without interfering with the action of the gearing of the wheel itself.

5. The wheel with its suspended pivot has nothing to do in changing the relative speed of the wheel and pinion into which it is geared, but it acts as a kind of '*remontoire*.' Supposing, for instance, the wheel below it, into which it is geared, is stationary; a force applied horizontally at the pivot would cause this remontoire wheel to *roll* on the one below it, and to give motion to the wheel and scape-wheel above it.

6. The suspending piece which carries the movable pivot and remontoire wheel has projecting from it, inwardly, a branch, which, while the clock is in motion, presses against a spring fixed horizontally and pivoted to the frame; the other end of which is made slender, and imparts a gentle pressure on a smooth wheel rapidly revolving, in order that a small amount of friction will have a great regulating power.

7. If the weight is applied to the clock when the pendulum is not vibrating, the force of the weight tends to give motion to the wheel below the remontoire one, and to all the wheels up to the air-fan; the spring is gently forced against the friction-wheel, and then prevents any further motion of the train. The spring in this position pushes the movable pivot outwards, and makes the remontoire wheel tend to move the one above it, and through it the scape-wheel.

8. If the weight is applied to the clock, and the pendulum is made to vibrate, the moment it begins to move, the scape-wheel moves its quantity for a beat; the remontoire wheel, by the very small force outwardly caused by the reaction of the break-spring, relaxes its pressure against the friction-wheel, and sets at liberty the train of the clock.

9. The spring is now driven back to the break-wheel, but before it can produce more than the necessary friction to keep the train in uniform motion, another beat of the clock again releases it. The repetition of these actions produces a series of impulses on the break-wheel of such a force and nature as to keep the train freely governed by the pendulum.

10. The small motion of the remontoire wheel pivot to and fro is equal only to about $\frac{1}{100}$ th of an inch.

The above description will give a general idea of the arrangement adopted; it may be mentioned that instead of friction produced by a spring, the remontoire wheel may be made to act on an air-fan inclosed in a box, through the openings in the periphery of which, more or less air will be allowed to pass according to the force of the train.

The uniform rotatory motion obtained by this clock as far as experiments can be made by applying widely different weights, and comparing the times with a chronometer, is perfectly satisfactory.

A clock constructed on the same principle, connected with, and giving motion to, a cylinder, will, it is presumed, make an excellent chronograph.

*Southampton Street, Strand,
May 13, 1868.*

On a persistent Marking on Jupiter. By J. Browning, Esq.

The first in order of date of the two drawings of *Jupiter* which I have now the honour to submit to the Society, was made on Sept. 12, 1867, at 10.15 P.M., with the Barnes $10\frac{1}{4}$ -in. reflector, power 200. The second drawing was made with my own $12\frac{1}{2}$ -in. reflector, same power, on Dec. 22, 1867, at 5.30 P.M. On both these drawings a dark belt, to the N. of the bright equatorial cloud-belt, will be seen to have a rather uniformly corrugated appearance on the lower or northern edge.

This corrugation I have represented on the diagram I have here, which is enlarged from one of the drawings. During the interval between taking the two drawings, I frequently saw the marking I have described, whenever the air was sufficiently steady to allow me to use powers above 100.

I am well aware that markings on *Jupiter* have been observed to remain almost unchanged for some months at a time. But my reason for directing attention to this particular marking is that I have noticed, that in Mr. De La Rue's well-known beautiful drawing of *Jupiter* taken in October 1856, a marking greatly resembling this is shown in exactly the same position.* I am therefore, inclined to think that this mark may possibly indicate the conformation of the surface of the planet, or at least some peculiar condition of this portion of the planet's atmosphere.

* The mark can only be recognised in Mr. De La Rue's own engraving from his drawing, it is not shown in any of the numerous woodcuts which have been copied from it.

Observations of the Zodiacal Light. By Major Tennant.

Jan. 23. Lat. about $17^{\circ} 30'$, N.—Conspicuous but ill-defined vertex about half way between γ and α Tauri and 3° N. of line.

Jan. 27.—Not so bright and more confused. Lat. 12° N. The bright light has its vertex near μ Piscium, and it is more faintly traceable to ξ^1 Ceti.

Jan. 28.—Moonlight. Lat. $11^{\circ} 30'$. Traceable notwithstanding young Moon to $\circ$ Piscium.

Jan. 29.—*Venus* seen easily at half an hour after noon. *Jupiter* invisible.

Feb. 10, *Madras*.—Moonlight compelled observations too early in evening, but traced Zodiacal Light to near δ Arietis.

On Saturday, February 23, the vertex of the Zodiacal light was not visible, the light merged in that of the borders of the Milky Way. I have never seen any appearance of angularity in the light. I have watched it from sunset at intervals till 9 P.M., and after the glow of sunset was gone have always found the shape a portion of a long ellipse, or parabola, ill defined at the outlines, and fading away, and with a marked condensation of light towards the axis and horizon. I will endeavour to estimate the position of the axis in future, but it is very difficult to place the lower end among the stars. The brightness of *Venus* much interferes with observation of that part till it has set.

Calcutta, March 1, 1868.

Occultation of γ Tauri, 28 March, 1868. By John Joynson, Esq.

Lens $3\frac{1}{2}$ -in., Power 60.

Disappearance	^h 9 ^m 2 ^s 48.5	G.M.T.
Reappearance	9 58 20.4	„

At the disappearance the dark limb of the Moon was clearly seen, and in both cases the time was deemed exact.

Long.	^h 0 ^m 12 ^s 7 W.
Lat.	$53^{\circ} 28' 24''$ N.

Waterloo, near Liverpool,
April 3, 1868.

Eclipses of Jupiter's Satellites, observed at Windsor, New South Wales. By John Tebbutt, Jun. Esq.

The accompanying observations of Eclipses of *Jupiter's Satellites* were made with a refractor of $3\frac{1}{4}$ inches aperture and 4 feet focal length. A magnifying power of about 90 was employed in the observations of July 20th, 24th, and 25th, 1867; but, in all the other observations a power of 120 was used. The times were noted by means of an eight-day half-seconds chronometer of Parkinson and Frodsham's construction. The last column contains a comparison of the observed times with those in the *Nautical Almanac*, the longitude employed for the comparison being $10^h 3^m 15^s.7$ E. Signals by electric telegraph exchanged between Mr. Smalley and myself, give $1^m 30^s.04$ as the longitude of my Observatory west of the Sydney Observatory. The longitude of the latter, finally deduced by the Rev. W. Scott from comparisons of the Sydney Moon culminations with corresponding observations at Greenwich in 1860 and 1861, and at the Cape of Good Hope in 1859, is $10^h 4^m 45^s.7$ E. of Greenwich: (see the vol. of *Sydney Astronomical and Meteorological Observations* for 1861). $10^h 4^m 45^s.7$ minus $1^m 30^s.0$ gives $10^h 3^m 15^s.7$, therefore, as the longitude of my Observatory east of Greenwich. I may mention that twenty-six transits of the Moon's first limb and four of the second observed here in 1866, and compared with the *Nautical Almanac*, give $10^h 3^m 19^s.1$ E., and eighteen of the first limb in 1867, $10^h 3^m 23^s.1$ E. as the approximate longitude. These culminations were observed by means of a Transit of 2.1 inches aperture, mounted on a substantial pier, and the chronometer above mentioned.

The following correction should be made in my observations of *Argus*, published in page 83 of the 26th vol. of the *R. A. S. Notices*:—

In the 12th line from the bottom, for 1818, read 3818.

Eclipses of Jupiter's Satellites, observed at Windsor, New South Wales, in the years 1866 and 1867.

Date. 1866.	Satellite.	Phase.	Windsor M.T.			App. Error of Naut. Alm.		
			h	m	s	m	s	
June 4	I.	Disappearance	11	27	50.5	—0	3.9	
28	II.	ditto	9	36	14.6	—0	26.4	
28	III.	ditto	11	22	22.8	+0	33.5	
July 6	I.	ditto	8	1	25.5	+0	35.9	
23	II.	Reappearance	9	22	49.6	+0	7.1	
Aug. 17	II.	ditto	6	25	39.9	+0	54.4	
24	II.	ditto	9	2	6.4	+0	18.5	
Sept. 6	I.	ditto	9	3	59.2	—0	16.6	
8	III.	ditto	6	47	19.2	+3	9.0	

Date. 1866.	Satellite.	Phase.	Windsor	App. Error
			M.T. h m s	Naut. Alm. m s
Sept. 13	I.	Reappearance	10 59 6.9	—0 3.0
15	III.	Disappearance	7 23 0.5	+1 46.1
15	III.	Reappearance	10 48 8.2	+3 32.5
18	II.	ditto	6 9 28.9	+0 3.2
22	I.	ditto	7 23 22.8	—0 7.9
25	II.	ditto	8 46 23.8	—0 3.4
Oct. 15	I.	ditto	7 38 33.0	—0 13.4
Nov. 14	I.	ditto	9 49 2.6	—0 43.8
Dec. 3	III.	ditto	7 3 49.9	+0 23.5
July 20	III.	Disappearance	11 38 0.1	+0 22.0
24	II.	ditto	8 54 4.0	—0 6.8
25	I.	ditto	9 36 42.9	+0 4.1
27	III.	ditto	15 36 57.6	+1 42.7
31	II.	ditto	11 28 6.8	+0 30.0
Aug. 1	I.	ditto	11 30 55.3	+0 24.8
10	I.	ditto	7 54 21.6	+0 23.8
17	I.	ditto	9 49 20.4	+0 15.5
30	IV.	Reappearance	6 19 32.6	+0 7.3
Sept. 18	I.	ditto	8 43 14.2	—0 1.2
Oct. 7	III.	ditto	11 17 29.2	+1 34.5
11	I.	ditto	8 59 42.8	—1 6.4
18	I.	ditto	10 54 14.3	+0 1.4
19	IV.	Disappearance	8 32 9.0	+6 40.2
19	IV.	Reappearance	12 52 19.7	+0 39.3
21	II.	ditto	8 1 33.9	—0 53.5
Nov. 5	IV.	ditto	7 7 52.9	—2 50.2
19	I.	ditto	7 35 0.9	—0 2.2
19	III.	Disappearance	8 4 23.8	+1 32.6
22	II.	Reappearance	7 46 49.7	—1 40.2
Dec. 12	I.	ditto	7 51 15.6	—0 26.0

Remarks.

1866.
 June 4. Good observation; definition very good.
 28. Full Moon present. The disappearance of the II. Satellite was observed in clear sky; that of the III. Satellite through a thin cirrus cloud.
 July 6. Planet ill defined and boiling. Final disappearance noted; the satellite had disappeared and reappeared a few seconds earlier.
 23. Definition very good, but time probably rather late, owing to proximity of satellite to planet's limb.
 Aug. 17. Excellent definition.
 24. Night beautifully clear, but Moon near her opposition, and not far from planet. Good observation.
 Sept. 6. Thin clouds flying across planet, but images bright and well defined at reappearance.

- ^{1866.}
Sept. 8. Night calm, and beautifully clear.
13. Calm, and sky beautifully clear. Definition very good.
15. Sky very clear. Telescope vibrated slightly at disappearance, but definition pretty good. Excellent definition at reappearance.
18. Observation during twilight, the Sun's upper limb having disappeared below the horizon just 23'3 minutes previously. Sky beautifully clear, and definition good. Moon in first quarter, and not far from planet.
22. Definition pretty good.
25. Good definition.
Oct. 15. Night beautifully clear, and definition very good.
Nov. 14. Imperfect observation through cloud. Planet rather low and near Moon.
Dec. 3. Satellite first perceived in the twilight at time noted; the other three satellites had shortly before become visible.
- ^{1867.}
July 20. Very good definition, but Moon about 3° distant from planet.
24. Planet low, but definition good. I thought I could just perceive a faint trace of the satellite again for a moment six seconds after the time noted.
25. Excellent definition.
27. Sky hazy; bad observation.
31. Sky hazy; bad definition.
Aug. 1. Clear sky; good definition.
10. Planet boiling; observation unsatisfactory.
17. Sky clear about planet, but Moon present. Definition pretty good, but images rather tremulous.
30. Sky cloudless, but twilight had scarcely disappeared. Planet low and boiling.
Sept. 18. Clear calm night.
Oct. 7. Good observation. Definition pretty good, but Moon present.
11. Moon present, and sky overspread with thin cloud.
18. Excellent definition, but observation probably a second or two late.
19. Definition unusually good at disappearance, and immersion very gradual. Images not so well defined at reappearance, and somewhat tremulous. Observation, however, pretty good.
21. Sky clear, and definition pretty good.
Nov. 5. Unsatisfactory. At the time noted the satellite was plainly distinguishable, and almost in contact with another satellite. The fourth satellite came out so nearly in a visual line with the other as to be hardly distinguishable from it for some time.
19. Excellent definition in both cases, but the disappearance was very gradual.
22. Sky very hazy.
Dec. 12. Sky very clear. Definition good, but images rather tremulous.

*Windsor, New South Wales,
February 28, 1868.*

Further Notice of the Lunar Crater Linné.

By the Rev. T. W. Webb.

Since the communication of my previous remarks on this object, I have fortunately obtained an observation which I hope may be thought worthy of the honour of being laid before the Society.

1868, March 30. $9\frac{1}{3}$ -inch silvered glass speculum; definition generally unsteady, with a tendency to double images, but at intervals quiet and clear. Terminator through the "pass" between *Caucasus* and the *Apennines*: the ring of *Cassini* coming into sight.

Linné was speedily made out with 450 as a minute black crater elongated N. and S. with a very narrow wall; the brightest part of the whole object being the rise of the *glacis* on the W. side. 212 had barely power enough; but at times the little black crater was quite certain. Single lens about 275, certain and clear at times. 450 again; sometimes very plain, at others blurred. I see plainly the traces of the white cloud, and that *Linné* (the minute crater) is central. The crater is barely half the size of *Linné* A. Afterwards it was extremely distinct with 212, and could be glimpsed with 170. The commencement of the white cloud was very evident with 65.

I am confident that, under the present illumination, there is nothing visible on the site of *Linné* but the minute crater, and the traces of the cloud.

The occasional clearness of definition was proved by my first sight of a very difficult object, obligingly mentioned to me by Mr. Knott, the minute crater on *Posidonius* γ ; which I could see with 450, and afterwards 212 showed me at times even its very narrow ring.

On the two following nights the black crater of *Linné* diminished, as the white cloud increased, in visibility: on neither occasion was the definition equal to that of the 30th.

Though the command of the object which I possessed on the 30th left no doubt whatever on my mind, it was with great pleasure that I received the following confirmation from Mr. With of Hereford, who had been observing the Moon on the same night:—

"Definition unsteady, but wonderfully sharp at times: a tendency to double image from atmospheric disturbance. Aperture $12\frac{1}{8}$ -inches silvered glass; focus $6\frac{1}{2}$ feet; power $300 \pm$. During moments of steady vision the crater of *Linné* seen as a black spot surrounded by a narrow brilliant ring. Ring considerably brighter than the 'cloud.' Crater not round—elongated N. and S. Seen several times during a period of about 30 minutes."

The accurate eye and the extraordinary optical advantages employed in this latter observation induce me to hope that the Society will accept the verification as one of no ordinary value,

especially as regards the elongated form. On the night in question I was under an impression that it had been so delineated by Mr. Huggins, but this I find was a mistake, and I am not aware that it has been so seen by any previous observer.

Hardwick Parsonage, April 15, 1868.

On the Lunar Crater Linné. By C. L. Prince, Esq.

I beg to communicate to the Society the following observations respecting the Lunar Crater *Linné*:—

1867, July 8th. With a power of 140 on my telescope of 6·8 inches aperture and 12 feet focal length, *Linné* presented a cloudy appearance only; but, with the power increased to 378, I could, by glimpses, distinguish the small black Crater.

July 9th. *Linné* appeared as a cloudy spot.

July 10th. The small black circular crater easily visible; but the definition was not good enough to enable me to trace the edge of external shallow one.

Aug. 8th. *Linné* merely a cloudy spot.

Nov. 3d. With a power of 288 I saw *Linné* to great advantage this evening, as a fairly defined crater, within which was an elevation, having a small circular crater on its summit. A thin line of shadow was visible within the western wall. The eastern wall was occasionally visible, but its elevation appeared very trifling.

1868, March 1st. I observed *Linné* very satisfactorily for about twenty minutes before the Moon was obscured by clouds. The shallow crater was distinctly visible on the western side, but not on the eastern. The western slope of the somewhat conical elevation had a very rugged surface and an overhanging crag near the top. It was brilliantly illuminated by the strong Sun-light to the very edge of the small crater, which was encircled by a ring of metallic lustre. I again observed that this little crater is both circular and deep; the interior shadow being very dark. The usual cloudiness was not seen, and the general colour of the *Mare* was maintained to the wall of the shallow crater.

On the following evening *Linné* was merely a cloudy spot.

May 1st. The Moon being nine days old, and *Linné* far removed from the terminator, I was not a little surprised to see the small crater beautifully distinct, about 7 P.M. It appeared, as heretofore, perfectly circular; its interior shadow as black as it was on March 1st, and in fine contrast with its bright edge. Its depth must be very remarkable, considering the elevation of the Sun on the ninth day of the Moon's age. Very little cloudiness was visible, and this gradually disappeared as I increased the magnifying power from 140 to 430. The atmosphere at 8 P.M. was so diaphanous that I was able to use rather high powers to

great advantage. The ascent from the base of the central elevation to its summit is much shorter and more precipitate on the western than on the eastern side. The position and appearance of the small crater, given by Mr. Huggins, at page 296, vol. xxvii. of the *Notices*, appear to me very correct, had its diameter been a little larger.

Although the definition was unusually fine from 7 to nearly 9 P.M., on the 1st inst., yet at 10 P.M., in consequence of the wind having shifted suddenly to the eastward, it became so bad that the whole of *Linné* was at once converted by it into a confused, cloudy, white patch, without a trace of the crater being visible.

Various observations of my own and others now lead me to the belief that no physical change has taken place in any part of *Linné*, and that the different aspects which it has presented to different observers must be ascribed to the ever-varying conditions of our own atmosphere.

Observatory, Uckfield, May 6, 1868.

Note on the Lunar Crater Linné. By Mr. Birt.

Linné.—The observations made on the 30th March last, which have come under my notice, are so interesting that I am induced to submit a synopsis of them with a view of soliciting further attention to this now remarkable object.

The white spot was observed as such by Messrs. Key, Webb, Buffham, and Crossley.

Mr. Crossley remarks that the obscuration round the crater appeared circular, and somewhat dished, but badly defined at the edges.

The large shallow crater was observed by Capt. Noble (*Monthly Notices*, vol. xxviii. p. 187), and by Mr. Huggins, who describes the western wall as much higher than the other. (*Report of the Proceedings of the R. A. S. in Astronomical Register*, No. 65, p. 103.)

The small crater was seen by the Rev. H. C. Key, who speaks of it as being situated on the summit of a gradually rising mound; the Rev. T. W. Webb, who saw it elongated N. and S., black inside, sharp narrow ring. Mr. Webb adds, that his observation was confirmed by Mr. With. Mr. Crossley's observations will be found in the *Monthly Notices*, vol. xxxviii. p. 187. It was also seen by Mr. Huggins; see *Astronomical Register*, as above. Mr. Buffham saw a round bright spot towards the W. side, about $\frac{1}{4}$ (or a little more) of the diameter of the light circle, with a kind of gray shading near the middle of the white spots E. of the bright spot as shown by his sketch. A correspondent (T. P.) of the *Register* says that *Linné* was seen of a small crater form with a central black spot surrounded by a thin bright ring.

By the period of similar phase, viz. $59^d 1^h 28^m$, after which interval the terminator will pass over nearly the same portion of the Moon's surface; the variation of the Sun's declination at the Moon slightly changing the angle which the terminator makes with the meridian—*Linné* will be almost similarly situated with regard to the terminator, on May 28, 1868, a slight alteration in the Sun's altitude being produced.

An interval of 442 days 23 hours will again bring the terminator very near *Linné*, about an hour earlier than the time of the observations of March 30. This will occur in 1869, on the evening of June 16, when the angle of illumination will be nearly similar; the Sun in the mean time having passed its greatest S. declination, and approached the Moon's equator; its declination at the Moon never exceeds $1^\circ 32' 9''$. The quantities stand as under :—

1868	March 30	$\odot - \Omega = 217^\circ 13' 5''$	S dec. approaching Solstice
	May 28	$\odot - \Omega = 277^\circ 38' 1''$	S dec. past Solstice
1869	June 16	$\odot - \Omega = 315^\circ 54' 1''$	S dec. approaching Equinox.

On the last two mentioned days, other circumstances being equal, *Linné* may be expected to present similar phenomena to those noticed on March 30, so far as illuminating angle is concerned. Libration will, however, affect the visual angle, and should good observations be obtained, it may be worth while to compute the effect produced by the variation of the two angles.

Cynthia Villa Observatory, Walthamstow,
1868, May 5.

Ephemeris of Brorsen's Comet. By Dr. C. Bruhns.

Perihelion passage 1868, April 18.4393.

1868.		α		δ	Log. r	Log. Δ	
$\odot$ Berlin T.		h	m	s			
May 10		5	58	51	+ 44 20.8	9.8701	9.9830
11		6	7	16	45 3.9		
12			15	55	45 44.8		
13			24	48	46 23.3		
14			33	54	46 59.3	9.8963	9.9721
15			43	14	47 32.6		
16			52	46	48 3.0		
17		7	2	29	48 30.4		
18			12	24	48 54.6	9.9224	9.9643
19			22	28	49 15.8		
20			32	40	49 33.5		
21			42	59	49 47.7		
22			53	22	49 58.5	9.9480	9.9600

1868. O ^b Berlin T.		α		δ		Log. r	Log. Δ
		h	m	s	$^{\circ}$	$'$	
May	23	8	3	49	50	5'6	
	24		14	17	50	9'3	
	25		24	44	50	9'3	
	26		35	9	50	5'9	9'9728
	27		45	29	49	58'9	9'9593
	28		55	43	49	48'6	
	29	9	5	48	49	35'0	
	30		15	44	49	18'2	9'9966
	31		25	29	48	58'3	9'9622
June	1		35	2	48	35'6	
	2		44	22	48	10'2	
	3		53	28	47	42'3	0'0194
	4	10	2	19	47	12'0	9'9688
	5		10	54	46	39'5	
	6		19	15	46	5'0	
	7		27	20	45	28'8	0'0411
	8		35	9	44	50'9	9'9786
	9		42	43	44	11'5	
	10		50	2	43	30'9	
	11	10	57	5	+ 42	49'2	0'0617
	12	11	3	54	42	6'5	9'9913
	13		10	29	41	23'1	
	14		16	51	40	38'9	
	15		22	59	39	54'1	0'0813
	16		28	54	39	8'8	0'0067
	17		34	57	38	23'2	
	18		40	8	37	37'3	
	19		45	27	36	51'4	0'0999
	20		50	36	36	5'5	0'0237
	21		55	35	35	19'6	
	22	12	0	24	34	33'9	
	23		5	3	33	48'3	0'1177
	24		9	34	33	2'9	0'0424
	25		13	56	32	17'9	
	26		18	10	31	35'2	
	27		22	17	30	48'8	0'1346
	28		26	17	30	4'8	0'0622
	29		30	9	29	21'2	
	30		33	55	28	38'1	
July	1		37	34	27	55'4	0'1506
	2		41	7	27	13'2	0'0829
	3		44	35	26	31'6	
	4		47	57	25	50'5	
	5		51	14	25	10'0	0'1660
							0'1040

1868.		α		δ	Log. r	Log. Δ
o ^b Berlin T.		^h	^m ^s	^o [']		
July	6		54 26	24 30'0		
	7		57 34	23 50'5		
	8	13	0 37	23 11'6		
	9		3 37	22 33'2	0'1806	0'1252
	10		6 33	21 55'4		
	11		9 24	21 18'2		
	12		12 12	20 41'5		
	13		14 58	20 5'4	0'1947	0'1466
	14		17 40	19 29'8		
	15		20 19	18 54'8		
	16		22 55	18 20'3		
	17		25 28	17 46'4	0'2081	0'1677
	18		27 58	17 13'0		
	19		30 26	16 40'1		
	20		32 51	16 7'8		
	21		35 14	15 36'0	0'2209	0'1887
	22		37 35	15 4'6		
	23		39 54	14 33'8		
	24		42 11	14 3'4		
July	25	13	44 25	+ 13 33'6	0'2333	0'2092
	26		46 38	13 4'2		
	27		48 49	12 35'3		
	28		50 58	12 6'9		
	29		53 6	11 39'0	0'2451	0'2293
	30		55 12	11 11'4		
	31		57 17	10 44'3		
Aug.	1		59 21	10 17'6		
	2	14	1 23	9 51'5	0'2565	0'2489
	3		3 24	9 25'7		
	4		5 23	9 0'2		
	5		7 21	8 35'2		
	6		9 19	8 10'6	0'2675	0'2679
	7		11 15	7 46'4		
	8		13 10	7 22'5		
	9		15 4	6 59'0		
	10		16 57	6 35'9	0'2780	0'2865
	11		18 49	6 13'1		
	12		20 40	5 50'7		
	13		22 30	5 28'6		
	14		24 20	5 6'8	0'2882	0'3044

Instruments for Sale.

A Refractor, of 8 inches aperture and 10 feet focal length, mounted equatorially by Cooke and Sons, with circles finely divided in silver; driving clock, &c., complete. The object-glass, by Alvan Clarke, is a very fine one, and was formerly in the possession of the late Rev. W. R. Dawes. The instrument is at present mounted in the Observatory of Mr. Huggins, at Upper Tulse Hill, to whom application is to be made.

A 7-foot Equatoreal, by Simms. Aperture 4.9 inches; declinated circle, 18 inches; hour circle, 15 inches; also an 18-inch transit circle. Apply to the Rev. J. Slatter, Streath Vicarage, Berks.

ERRATUM.

P. 6, line 12, *dele* previously.

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MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

VOL. XXVIII.

June 12, 1868.

No. 8.

Admiral MANNERS, President, in the Chair.

C. H. H. Cheyne, Esq., 1 Dean's Yard, Westminster;
Henry Wm. Hollis, Esq., Ormston Manor, Derby;
Wm. Rossiter, Esq., Collingwood Street; and
Robert Wm. Skiffington Lutwidge, Esq., Barrister-at-Law,
were balloted for and duly elected Fellows of the Society.

On the Variable Star η Argûs and its Surrounding Nebula.
By Sir J. F. W. Herschel, Bart.

The changes recorded by Mr. Abbott, in his communications to this Society, published in vols. xxiv. and xxv. of the *Monthly Notices*, and more especially in the *Notice* which has just appeared (vol. xxviii. p. 200), are so very astonishing that it is high time the attention of every astronomer in the southern hemisphere provided with instruments at all competent to show, I will not say all the details—but—the brighter portions of the nebula, should be directed to its delineation, and to the relative situations of every star within 10' or 15' of the principal star. There is no phenomenon in nebulous or sidereal astronomy that has yet turned up, presenting anything like the interest of this, or calculated to raise so many and such momentous points for inquiry and speculation. The question here is not of minute variations in subordinate features, which may or may not be attributable to differences of optical power in the instruments used by different observers, as in the case of the nebula in *Orion* (the only one comparable to it in magnitude, complexity, and brightness), but of a total change of form and character—a complete subversion of all the greatest and most striking features—accompanied with an amount of relative

movement between the star and the nebula, and of the brighter portions of the latter *inter se*, which reminds us more of the capricious changes of form and place in a cloud drifted by the wind than of anything heretofore witnessed in the sidereal heavens. In fact, not only as compared with the appearance of the nebula in 1834-7, which my delineations record, does Mr. Abbott's diagram of 1868 exhibit so astonishing a dissimilarity; but, when compared with the drawing given by himself at so recent a date as 1863 (vol. xxiv. p. 5), the difference is such that no one could possibly suppose the two representations referred to one and the same object.

η Argûs itself, though a variable star of the most extraordinary character, is nearly devoid of proper motion: the annual change due to this cause, in R.A. and N.P.D., as given in the Catalogue of the British Association, being only $-0^{\text{sec}}.001$ and $-0''.09$, so that it is entirely owing to movements going on within the nebula itself that the change must be owing. But here comes the most astonishing part of the whole affair. The neighbourhood of η Argûs is thickly sown over with small stars. Of these, within the compass of a little more than a square degree, having η in the middle, I determined in 1834-7 the situations and apparent magnitudes of upwards of 1200; and, during all the course of my observations, never found reason to suspect the situations of any of these to be variable either *inter se* or with respect to η . Now Mr. Abbott's figure, as given in the recent Number of the *Monthly Notices*, shows this star accompanied by 150 stars of various magnitudes within a field of view (so I interpret the subscript figures $1^{\circ} 07' 47''$) of $1^{\circ} 8'$; and of these I have not been able satisfactorily to identify any one individual with any one in my Catalogue.

To be quite satisfied on this point, I laid down upon his figure a set of lines corresponding to the meridians and parallels of my chart,* being guided in their direction by the letters N S and E W (which I presume to express the situations of the North and South, and East and West points of his field of view at the moment of delineation); in their distance from each other in P.D. by the diameter $68'$ of the circle, containing exactly 17 intervals of $4'$, the distance between the parallels on my chart ($4' = 1000$ micrometer parts), and in R.A. so as to correspond in due proportion to the intervals of $50^{\text{sec.}}$ of time between my meridians. This done, the places of Mr. Abbott's principal stars (within the limits of my chart) were read off as nearly as the small scale of the figure would allow, and are here set down—the magnitudes assigned being according to the best judgment I could form, from the size of the dots expressing them in the engraving, taking η itself as 6 mag. As regards the larger stars, this can hardly be very erroneous, though, as respects the smaller ones, no conclusion can be formed, since, though Mr. Abbott

* “Cape Observations,” Plate ix.

states the *focal lengths* (5 feet) of the telescopes he used, he nowhere mentions their apertures.

Star's Mag.	Δ R.A. from η in Seconds of Time.	Δ N.P.D. from η in Microm. parts, each = 0''·004.	Star's Mag.	Δ R.A. from η in Seconds of Time.	Δ N.P.D. from η in Micr. parts, each = 0''·004.
$\eta = 6$ m.	0	0	8 m.	-42	-1600
6 m.	-165	-5950	7.8 m.	+36	+5200
9 m.	-147	-1750	7.8 m.	+45	+6000
9 m.	-120	-1400	8 m.	+77	-450
8 m.	-55	-900	8 m.	+80	+400
8 m.	-45	-1850	8 m.	+87	-1250

The following are the principal stars within the limits of Mr. Abbott's field of view, as given in my Catalogue* :—

Star's Let- ter and Mag.	Δ R.A. from η in Seconds of Time.	Δ N.P.D. from η in Microm. parts = 0''·004.	Star's Let- ter and Mag.	Δ R.A. from η in Seconds of Time.	Δ N.P.D. from η in Micr. parts = 0''·004.
$\eta = 2$ m.	0	0	$\lambda = 8$ m.	+ 37·8	-4143
$\omega = 8$ m.	-148·0	-1332	$\delta = 8$ m.	+ 66·7	-5486
O = 7 m.	- 65·5	-2023	$\sigma = 9$ m.	+ 78·9	+5014
C = 8 m.	- 51·6	+ 539	$\kappa = 8$ m.	+155·9	-1726
U = 7 m.	- 38·5	+4627	W = 6 m.	+158·3	+2782
D' = 8 m.	- 29·1	+ 860	$\gamma = 7$ m.	+178·9	+3441
D = 8 m.	- 28·8	+ 798			

The utter disagreement of these two lists of the principal stars is apparent, and renders it unnecessary to go into a comparison of those of smaller magnitude.

Conceiving it possible, however, that the letters N, S, E, W, may be misplaced in Mr. Abbott's diagram, or that the nature of the inversion of his eye-piece may have been, by myself, misapprehended, I laid down, on the same scale, a miniature of my chart on thin paper, with the meridians and parallels, placing on it in their proper positions all the stars in this latter list. Then, oiling the paper so as to render it transparent, it was laid down on Mr. Abbott's diagram, the two stars η in each being brought to coincidence. Turning then the oiled chart round on the diagram, no situation could be found to bring about any tolerable coincidence of the stars in the one and the other. The same result was obtained when the oiled chart was reversed (laid *face downwards*) on the diagram, and turned round in the same way.

What then are we to conclude? Not only the nebulous masses would appear to have drifted far away from their situations in 1835, but the stars of the whole region over an area of nearly two-thirds of a square degree, including stars of the 6th, 7th, and 8th magnitudes, to have also either assumed new configurations *inter se*, or to have bodily fled away and given place to a new set!

* "Cape Observations," pp. 42, *et seq.*

Again, within a circle of 6' radius round η , in Mr. Abbott's diagram occur 19 minute stars. In my chart, within a circle of the same radius, are laid down 57, of which two are of the 8th, four of the 10th, and two of the 11th magnitudes, but among all these not one can be satisfactorily identified with any of his. The best approach in general appearance is that of the line of five very small stars in close vicinity to η and to the immediate south of it, which may be considered as somewhat to resemble the crooked line of stars G, (ϵ), (ζ), (η), (θ), in my chart. But *these* are quite otherwise situated with respect to η , and their general direction makes an angle of 70° with the parallel (from sp to nf).

Another very puzzling feature in Mr. Abbott's description is the brightness he ascribes to the nebula, which he states to "give out fully twice as much light as that of the Nubecula major," "irrespective of size." How far the diminution of light in η from the 2d to the 6th magnitude may affect the visibility to the naked eye of the nebula in a dark night, I cannot pretend to say; but on no occasion do I remember to have perceived with the naked eye any nebulosity about it even in a dark night, and assuredly not in a twilight, such as just to allow stars of 2.3 mag. to become visible. *Such* a twilight effectually obliterates both the Nubeculæ, which, however, are both—the N. major especially—very conspicuous objects in a dark night.

It is much to be wished that some southern observer furnished with an equatorially mounted telescope would *without further delay* set to work in earnest, and map down the stars visible within this most interesting area, down at least to the 10th or 11th magnitude. Possibly I may have done Mr. Abbott injustice by assuming that his diagram is intended to convey any *delineation* at all of the stellar contents of his field of view; or anything beyond the forms of the nebulous masses, as existing *among* scattered stars. But the question once raised is of the last importance and *must* be settled; especially in regard to what he himself says, *Monthly Notices*, vol. xxv. p. 4, as to the "increased number" [since 1837] "of brilliant isolated stars with a change in the position of η Argûs," as "the effect produced with a 5-foot achromatic;" in obvious reference to the *nebular hypothesis* of the formation of stars and planets by the condensation of nebulous matter. And this leads me to observe that, having taxed in vain my recollection as to the authorship of the passage which he there ascribes to me* on the subject of this theory, and not having

* "It will appear" . . . "that every succeeding state of nebulous matter is the result of the action of gravitation, and by such steps the successive condensation of it is brought to a planetary or stellar condition. Several instances are on record which connect the planetary with the stellar appearance. In those instances wherein the collection of nebulous matter was very extensive, subordinate centres of attraction could not fail to be established, around which the adjacent particles would arrange themselves, and thus the whole mass would in process of time be transformed into a determinate number of discrete bodies, which would ultimately assume the condition of a cluster of stars."—*Monthly Notices*, vol. xxv. p. 4.

succeeded in finding it in any of my published writings, I shall feel obliged to any friend who will refer me to the place where it occurs, as it certainly seems to convey a much more definite and decided view of the matter than I should *now* like to endorse.

Collingwood, June 8, 1868.

A determination of the Constant of Nutation from the observations in N.P.D. of Polaris, Cephei 51, and δ Ursæ Minoris, made with the Transit Circle of the Royal Observatory, Greenwich, 1851-1865. By E. J. Stone, Esq. (Abstract.)

The Transit Circle of the Royal Observatory, Greenwich, has been in regular use since the beginning of the year 1851, and the results, down to the year 1865 inclusive, are in the hands of astronomers. In the construction of the instrument no arrangements were provided for shifting the relative positions of the reading-microscopes, or the divisions under the microscopes, in any given position of the instrument. The same divisions are thus employed in the observation of a star for many years. This arrangement undoubtedly offers great advantages for the determination of a constant, like that of Nutation, where what we require is, that observations extending over many years should either be free from systematic error, or, which is quite as good for the present purpose, be affected only with constant errors. The division errors of the Greenwich Transit Circle were elaborately investigated in 1850 and again in 1857. The errors of the divisions under the microscopes, in the observations of the Nadir-point with the reflecting eye-piece, in the observations of *Polaris*, *Cephei 51*, and *δ Ursæ Minoris*, above and below pole, have also been separately investigated in 1857 and 1865.

The astronomical flexure of the telescope has been determined on the following occasions:—

Date.		Horizontal Flexure.
1850	Dec. 30	+ 0".41
1851	Feb. 5	+ 0".88
1852	Dec. 23	+ 0".20
1857	Jan. 5	+ 0".46
1857	Jan. 21	+ 0".66
1860	Sept. 1	+ 0".67
1864	Sept. 7	+ 0".76

The mean value of the horizontal flexure = + 0".58.

1867	April 25	- 0".34
1867	May 8	- 0".31
1867	May 13	- 0".37

Mean value of the horizontal flexure = $-0''\cdot34$.

In the autumn of 1865, the central cube of the transit-circle was pierced to allow of the adjustment of the wires of the collimating-telescopes on each other, without the necessity of first raising the transit-circle. In the operation of piercing the cube the state of strain of the instrument was so changed that the horizontal astronomical flexure of the instrument was found to be altered by nearly one second of arc. From the erection of the instrument to the time of piercing the cube, a discordance of a well-marked character had been observed between the nadir points, determined from observations with the reflecting eye-piece, and those resulting from observations of stars, north and south of the zenith, directly, and after reflexion at the surface of the quicksilver. With the change of sign in the flexure of the telescope, a change of sign in the law of the discordance $R - D$ has also been shown by the observations of 1866 and 1867. If the discordances between the nadir-points arise from imperfect correction under the assumed law ($= \text{constant} \times \sin Z D$), a slight abrupt change in the resulting N.P.D. of a star may be expected to take place with the piercing of the cube. Such a change would, to a very considerable extent, be destroyed by the method adopted in the Greenwich reductions of applying a correction to the final results for the discordance $R - D$. I have, however, thought it better, for my present purpose, to keep entirely free from the necessity of applying any empirical correction such as that for $R - D$, and have therefore terminated the investigation with the date of piercing the cube. As all the observations after September 1865 were made with the altered flexure, I have not been able to employ the observations of *Polaris* made in the year 1865: the annual group for this year would not be strictly comparable with preceding annual groups.

The observations made use of have been extracted from the N.P.D. ledgers printed in the volumes of *Greenwich Observations*, 1851 to 1865. Different division errors, values of assumed horizontal astronomical flexure, and nadir-points deduced from a combination of reflecting-eye-piece determinations with results obtained from observations of stars by reflexion, have been employed in the reduction of the results as extracted directly from the ledgers. As the nadir-points employed are mixed up with the adopted flexure and adopted division errors, I have thought it better to reduce all the observations to nadir-points determined with the reflecting-eye-piece alone. The following Tables give the data employed in the reductions of different years, the data adopted, and the corrections required to reduce the material to one uniform system.

Colatitude used	1851 to 1854	$38^{\circ} 31' 21''\cdot80$
	1855 to 1860	$22''\cdot00$
	1861 to 1865	$21''\cdot80$
Adopted colatitude		$38^{\circ} 31' 21''\cdot80$

Corrections for Division Errors + Effect of Astronomical Flexure,
as used in the Reductions.

	1851 & 1852.	1853 to 1856.	1857.	1858 to 1864	1865.
Nadir	+ 0 ^{''} 86	+ 0 ^{''} 63	+ 0 ^{''} 76	+ 1 ^{''} 02	+ 1 ^{''} 20
Polaris	+ 0 ^{''} 69	+ 0 ^{''} 60	+ 1 ^{''} 07	+ 1 ^{''} 09	+ 1 ^{''} 14
Polaris S.P.	+ 0 ^{''} 92	+ 0 ^{''} 84	+ 1 ^{''} 18	+ 1 ^{''} 40	+ 1 ^{''} 45
Cephei 51	+ 0 ^{''} 72	+ 0 ^{''} 63	+ 0 ^{''} 99	+ 0 ^{''} 99	+ 1 ^{''} 05
Cephei 51 S.P.	+ 0 ^{''} 79	+ 0 ^{''} 72	+ 0 ^{''} 92	+ 0 ^{''} 92	+ 0 ^{''} 96
δ Ursæ Minoris	+ 0 ^{''} 81	+ 0 ^{''} 71	+ 0 ^{''} 94	+ 0 ^{''} 94	+ 1 ^{''} 00
δ Ursæ Minoris S.P.	+ 0 ^{''} 79	+ 0 ^{''} 72	+ 0 ^{''} 92	+ 0 ^{''} 92	+ 0 ^{''} 96

Corrections for Division Errors + Effect of Astronomical Flexure,
adopted in this investigation.

Nadir	= + 0 ^{''} 75
Polaris	= + 0 ^{''} 64
Polaris S.P.	= + 0 ^{''} 97
Cephei 51	= + 0 ^{''} 73
Cephei 51 S.P.	= + 0 ^{''} 45
δ Ursæ Minoris	= + 0 ^{''} 64
δ Ursæ Minoris S.P.	= + 0 ^{''} 52

Numerical Corrections to the North Polar Distances of the Ledger
Results.

	1851 & 1852.	1853 to 1856.	1857.	1858 to 1864.	1865.
Polaris	+ 0 ^{''} 06	- 0 ^{''} 08	- 0 ^{''} 42	- 0 ^{''} 18	"
Polaris S.P.	- 0 ^{''} 16	- 0 ^{''} 01	+ 0 ^{''} 20	+ 0 ^{''} 16	
Cephei 51	+ 0 ^{''} 12	- 0 ^{''} 02	- 0 ^{''} 25	+ 0 ^{''} 01	+ 0 ^{''} 13
Cephei 51 S.P.	+ 0 ^{''} 23	+ 0 ^{''} 39	+ 0 ^{''} 46	+ 0 ^{''} 20	+ 0 ^{''} 06
δ Ursæ Minoris	- 0 ^{''} 06	- 0 ^{''} 19	- 0 ^{''} 29	- 0 ^{''} 03	+ 0 ^{''} 09
δ Ursæ Minoris S.P.	+ 0 ^{''} 16	+ 0 ^{''} 32	+ 0 ^{''} 39	+ 0 ^{''} 13	- 0 ^{''} 01

The value of the nutation-constant employed in the reductions
has been

9^{''}·25 from 1851 to 1856 inclusive.

9^{''}·224 from 1857 to 1865 ,,

The true value of this constant has been assumed

$$9''\cdot224 + x.$$

The following are the corrections for the effects of the pre-
cessional motion of the Earth's axis, which have been employed
to reduce the mean N.P.D.'s for each year to the year 1858.

Year.	Polaris.	Cephei 51.	δ Ursæ Min.
1851	$-2^{\circ} 14' 55.1'' + 18.839 - 11.792$		
1852	$-1^{\circ} 55' 30.6'' + 16.281 - 10.025$		
1853	$-1^{\circ} 36' 06.9'' + 13.678 - 8.284$		
1854	$-1^{\circ} 16' 84.0'' + 11.031 - 6.570$		
1855	$-0^{\circ} 57' 61.8'' + 8.339 - 4.884$		
1856	$-0^{\circ} 38' 40.4'' + 5.603 - 3.228$		
1857	$-0^{\circ} 19' 19.8'' + 2.824 - 1.600$		
1858	$0^{\circ} 00.0''$	$0^{\circ} 00.0''$	$0^{\circ} 00.0''$
1859	$+0^{\circ} 19' 19.0'' - 2.868 + 1.572$		
1860	$+0^{\circ} 38' 37.2'' - 5.780 + 3.117$		
1861	$+0^{\circ} 57' 54.7'' - 8.737 + 4.634$		
1862	$+1^{\circ} 16' 71.3'' - 11.738 + 6.122$		
1863	$+1^{\circ} 35' 87.1'' - 14.782 + 7.581$		
1864	$+1^{\circ} 55' 02.1'' - 17.871 + 9.012$		
1865	$+2^{\circ} 14' 16.2'' - 21.003 + 10.415$		

Polaris.

Assumed mean N.P.D., Jan. 1, 1858,—

$$1^{\circ} 26' 51''.222 + y.$$

Assumed proper motion in N.P.D. = $0''.00 + \delta p$.

The equations of condition for the yearly groups, are

Year.		w
1851	$y + 0.7598 x = + 0.026 + 7 \delta p$	32.06
1852	$y + 0.7443 x = - 0.034 + 6 \delta p$	35.10
1853	$y + 0.6324 x = - 0.108 + 5 \delta p$	26.46
1854	$y + 0.4591 x = - 0.180 + 4 \delta p$	45.81
1855	$y + 0.2174 x = - 0.015 + 3 \delta p$	33.23
1856	$y - 0.0203 x = - 0.026 + 2 \delta p$	34.66
1857	$y - 0.2739 x = - 0.069 + \delta p$	45.75
1858	$y - 0.4946 x = + 0.109$	57.44
1859	$y - 0.6650 x = + 0.092 - \delta p$	52.50
1860	$y - 0.7495 x = + 0.082 - 2 \delta p$	30.37
1861	$y - 0.7573 x = - 0.082 - 3 \delta p$	43.01
1862	$y - 0.6678 x = + 0.093 - 4 \delta p$	27.99
1863	$y - 0.5180 x = + 0.093 - 5 \delta p$	34.25
1864	$y - 0.2978 x = + 0.017 - 6 \delta p$	38.17

Multiplying each equation by the corresponding value of w ,

and reducing the equations to two by the method of least squares, we have the following equations for the determination of y and x .

$$\begin{aligned} 536.80 y - 84.204 x &= + 0''.472 + 211 \delta p. \\ -84.204 y + 167.257 x &= - 14.157 + 913 \delta p. \end{aligned}$$

From which we deduce

$$x = - 0''.091 + 6.1 \delta p$$

$$\text{or Nutation constant} = 9''.133 + 6.1 \delta p.$$

Cephei 51.

Assumed mean N.P.D. Jan. 1, 1858,—

$$2^{\circ} 44' 59''.8 + y.$$

Assumed proper motion in N.P.D. = $+ 0''.08 + \delta c$.

The equations of condition for the yearly groups are

Year.		w .
1851	$y + 0.413 x = + 0''.538 + 7 \delta c$	3
1852	$y + 0.074 x = + 0.040 + 6 \delta c$	3
1853	$y - 0.251 x = + 0.090 + 5 \delta c$	3
1854	$y - 0.563 x = + 0.240 + 4 \delta c$	9
1855	$y - 0.803 x = + 0.470 + 3 \delta c$	5
1856	$y - 0.948 x = + 0.483 + 2 \delta c$	6
1857	$y - 0.987 x = + 0.464 + \delta c$	5
1858	$y - 0.923 x = + 0.472$	12
1859	$y - 0.722 x = + 0.430 - \delta c$	14
1860	$y - 0.490 x = + 0.156 - 2 \delta c$	8
1861	$y - 0.166 x = + 0.278 - 3 \delta c$	6
1862	$y + 0.161 x = + 0.296 - 4 \delta c$	3
1863	$y + 0.480 x = + 0.102 - 5 \delta c$	12
1864	$y + 0.737 x = + 0.076 - 6 \delta c$	11
1865	$y + 0.918 x = + 0.238 - 7 \delta c$	5

Multiplying each equation by the corresponding value of w , and reducing the equations to two by the method of least squares, we have for the determination of x and y the following equations,—

$$\begin{aligned} 105 y - 26.157 x &= + 30''.470 - 99 \delta c \\ -26.157 y + 49.778 x &= - 16.085 - 133 \delta c \end{aligned}$$

From which we find

$$x = -0''.196 - 3.6 \delta c$$

or Nutation constant = $9''.028 - 3.6 \delta c$.

δ *Ursæ Minoris*.

Assumed mean N.P.D. Jan. 1, 1858,—

$$3^{\circ} 23' 55''.00 + y.$$

Assumed proper motion — $0''.03 + \delta m$.

The equations of condition for the yearly groups are

Year.		w .
1851	$y - 0.4546 x = 1.507 + 7 \delta m$	9
1852	$y - 0.1306 x = 1.526 + 6 \delta m$	9
1853	$y + 0.1980 x = 1.530 + 5 \delta m$	4
1854	$y + 0.5216 x = 1.597 + 4 \delta m$	9
1855	$y + 0.7748 x = 1.444 + 3 \delta m$	4
1856	$y + 0.9320 x = 1.260 + 2 \delta m$	4
1857	$y + 0.9928 x = 1.458 + \delta m$	9
1858	$y + 0.9464 x = 1.250$	9
1859	$y + 0.7488 x = 1.347 - \delta m$	9
1860	$y + 0.5524 x = 1.358 - 2 \delta m$	9
1861	$y + 0.1780 x = 1.228 - 3 \delta m$	4
1862	$y - 0.0990 x = 0.717 - 4 \delta m$	1
1863	$y - 0.4236 x = 1.238 - 5 \delta m$	9
1864	$y - 0.6977 x = 1.404 - 6 \delta m$	9
1865	$y - 0.8958 x = 1.146 - 7 \delta m$	4

Multiplying each equation by the corresponding value of w , and reducing the equations to two by the method of least squares, we have the following equations for the determinations of y and x :—

$$102 y + 23.149 x = 141.314 + 32. \delta m$$

$$23.149 y + 44.560 x = 32.588 + 76. \delta m$$

From which we find

$$x = +0''.013 + 1.75. \delta m,$$

or

$$\text{Nutation constant} = 9''.237 + 1.75. \delta m.$$

Taking the mean of the determinations of the Nutation constant from the observations of *Cephei* 51 and δ *Ursæ Minoris*, we find for its value

$$9''.1325 + 0.88 \delta m - 1.8 \delta c.$$

This value agrees almost identically with the value resulting from the discussion of the observations of *Polaris*, viz. :—

$$9''.133 + 6.1 \cdot \delta p.$$

Taking the mean of these values as our final result, we find for the Nutation constant,

$$9''.133 + 3.05 \delta p + 0.44 \cdot \delta m - 0.90 \cdot \delta c.$$

From the care bestowed upon the reduction of the observations to one uniform system, I am inclined to lay much more stress upon apparently small changes than would otherwise have been the case. I have been much surprised, therefore, to find that the colatitudes resulting from the yearly means of the observations of *Polaris*, above and below pole, differ considerably from the general average in an apparently systematic manner.

The observations of *Cephei* 51 and δ *Ursæ Minoris* are neither sufficiently numerous nor sufficiently well distributed to give very accurate determinations of the colatitude from year to year. The observations of *Cephei* 51, however, appear to give changes of colatitude something similar to those given by the observations of *Polaris*. In the case of the observations of δ *Ursæ Minoris* the corresponding changes are not well shown, or they are disguised so as not to be easily recognizable. The following table gives the corrections to colatitude, resulting from the observations of *Polaris* above and below pole, for the years 1851 to 1865:—

Corrections to Colatitude deduced from the Observations of
Polaris above and below the pole.

Year.	Correction.	Number of Observations	
		Above Pole.	Below Pole.
1851	+0.351	75	56
1852	+0.246	66	75
1853	+0.370	51	55
1854	+0.573	86	98
1855	+0.423	65	68
1856	+0.315	73	66
1857	+0.207	91	92
1858	+0.236	124	107
1859	+0.408	106	104
1860	+0.377	65	57
1861	+0.102	93	80
1862	+0.139	55	57
1863	+0.021	69	68
1864	+0.196	68	87
1865	+0.218	40	54

If we assume that the variation of these corrections depends upon the position of the Moon's Node, or correction

$$\begin{aligned} &= z + r \cos (\Omega - q) \\ &= z + r \cos q \cos \Omega + r \sin q \sin \Omega \\ &= z + x \cos \Omega + y \sin \Omega, \end{aligned}$$

we have the following equations for the determinations of x, y, z . The probable errors of the results will be considered as equal.

1851	$z - 0.439 x + 0.891 y = + 0.351$
1852	$z - 0.141 x + 0.986 y = + 0.246$
1853	$z + 0.218 x + 0.972 y = + 0.370$
1854	$z + 0.519 x + 0.850 y = + 0.573$
1855	$z + 0.781 x + 0.618 y = + 0.423$
1856	$z + 0.933 x + 0.348 y = + 0.315$
1857	$z + 0.997 x + 0.019 y = + 0.207$
1858	$z + 0.948 x - 0.303 y = + 0.236$
1859	$z + 0.785 x - 0.613 y = + 0.408$
1860	$z + 0.561 x - 0.822 y = + 0.377$
1861	$z + 0.231 x - 0.968 y = + 0.102$
1862	$z - 0.119 x - 0.988 y = + 0.139$
1863	$z - 0.419 x - 0.903 y = + 0.021$
1864	$z - 0.697 x - 0.711 y = + 0.196$
1865	$z - 0.872 x - 0.487 y = + 0.218$

These equations lead to the following for the determination of $x y z$:—

$$\begin{aligned} 15 z + 3.286 x - 1.111 y &= + 4.182 \\ 3.286 z + 6.323 x + 0.912 y &= + 1.447 \\ -1.111 z + 0.912 x + 8.551 y &= + 0.645 \end{aligned}$$

which give

$$\begin{aligned} z &= + 0.270 \\ x &= + 0.074 \\ y &= + 0.103 \end{aligned}$$

The sum of the squares of the corrected residuals,

$$= 0.164878.$$

If we apply the mean value of z only, the sum of the squares of the residuals will equal

$$0.280152,$$

or the error of mean square has been reduced from $0''.136$ to $0''.105$.

If this evidence be considered sufficient to indicate an apparent periodical change in the colatitude of the Greenwich Observatory, it may perhaps be taken as a proof of the yielding of the Earth's crust under the Moon's action, or referred to a systematic deformation of the atmosphere arising from the same cause. Very slight changes in the inclination of the general direction of the effective strata of the atmosphere would be sufficient to produce in the colatitude apparent variations of the required amount. It may, perhaps, not be out of place to recall the attention of astronomers to the results of the Rev. R. Main's attempts to determine the annual parallax of γ *Draconis*.^{*} From an elaborate discussion of the Greenwich Observations, extending over many years, made with two instruments of very different construction—Pond's Zenith Tube and Airy's Reflex Zenith Tube—the factor introduced to represent the annual parallax of γ *Draconis* came out a negative quantity. This anomalous result was deduced separately from a discussion of the observations with both these instruments.

Mr. Main's anomalous result for parallax might be explained by supposing that there exists a systematic deformation of the atmosphere with an annual period. The anomalies presented in the colatitude determinations from *Polaris* appear to be considerably diminished by supposing a systematic deformation of the atmosphere, with a period of 18 years. In this investigation an annual disturbance would, of course, be destroyed. It is curious, to say the least, that two investigations, which would appear the most favourable possible for the detection of systematic changes in the atmosphere, should each lead to anomalous results requiring apparently a very similar supposition for their explanation. I consider the discordances in the resulting colatitudes too systematic to arise from mere chance errors of observation.

Greenwich, 1868, June 12.

Observations of the Lunar Crater IV. Aⁿ 17, IV. A^z 39.

By W. R. Birt.

The extreme interest attaching to the crater *Linné* has induced me to submit to the Society the accompanying observations, principally made by the Rev. W. O. Williams of Pwllheli, North Wales, of a crater near the middle of the Moon, which has manifested similar phenomena, and I do so the more readily as having computed the solar altitudes for twelve hour intervals at the latitude of the crater, viz. 5° S., I have arranged the existing observations in the order of solar altitudes, commencing with sunrise at the equinoxes, by which it will be easily seen that below

^{*} *Memoirs*, vol. xxiv.; *Notices*, vol. xx. No. 7.

certain altitudes the crater-form is distinctly and often conspicuously visible, while with higher altitudes the crater formed is entirely lost.

There are one or two points of interest connected with this crater. With altitudes under 25° the crater-form on some occasions has been lost, while on others, with altitudes between 30° and 36° it has been detected. The most remarkable phenomenon is the appearance of *two bright spots* seen at altitudes between 48° and 85° . On the subject of these spots a few remarks may probably be permitted.

These two bright spots were first seen by Mr. Williams on May 4, 1868, 10.30 to 11.30, G.M.T. It does not appear that any one has observed the crater previously at so high a solar altitude as 48° – 54° . I also saw the two spots with the Crossley Equatoreal of 7.3 in. aperture on May 6, 1848, exactly as described by Mr. Williams, who observed them with an aperture of $4\frac{1}{16}$ inches, and noticed that there was a dark interval between them of about one-third of the diameter of either, they were about equal in brightness. Mr. Williams has seen them when the Sun was near its meridian altitude.

On Rutherford's Photogram, 1865, March 6, there is east of the spot IV. A $^{\alpha}17$, IV. A $^{\zeta}39$, a rather indistinct light circle with a somewhat dark interior, the whole very much less bright than IV. A $^{\alpha}17$, IV. A $^{\zeta}39$. It is possible that the east of the two bright spots may be this which favourable circumstances have rendered more distinctly visible as well as *brighter*. On Mr. De La Rue's Photogram, 1865, Oct. 4, IV. A $^{\alpha}17$, IV. A $^{\zeta}39$, is an *elongated* white spot, the elongation is towards the valley IV. A $^{\zeta}96$, which agrees with the line joining the two spots seen by Mr. Williams.

The spot IV. A $^{\alpha}17$, IV. A $^{\zeta}39$, is thus described in the British Association Lunar Catalogue,—

"A bright spot SSW of IV. A $^{\alpha}7$, $5''\cdot94$, Mag. $0\cdot37$, probably a crater on the NE. border of *Hipparchus*." Latitude 5° S.; longitude 2° W.

Note.—IV. A $^{\alpha}7$ is *Hipparchus F.* of Beer and Mädler.

Observations of IV. A $^{\alpha}17$, IV. A $^{\zeta}39$. Latitude 5° S.; Longitude 2° W.

Morning illumination.

No.	Year.	Date, G.M.T.	Authority.	Sun's Alt.	Bright- ness.	Character.
1	1867	May 11, $8\frac{1}{2}$	Birt	0° – 6°	... 0°	A shallow crater.
2	1868	Feb. 1, 5–6	Williams	6–12	...	Crater well seen.
3	1868	March 31, $7\frac{1}{2}$	Birt	6–12	...	Crater well defined.

No.	Year.	Date G.M.T.	Authority.	Sun's Alt.	Bright- ness.	Character.
4	1868	Jan. 3, 5-6	Williams	$12-18^{\circ}$	...	Discerned central cone, but not certain.
5	1868	Jan. 3	Baxendell	12-18	...	A well-marked, shallow crater.
6	1867	Nov. 5, 9-10	Williams	18-24	7	Very bright streak of interior shadow on the west.
7	1868	April 1, 5-6	Williams	18-24	4	Whitish patch of light.
8	1867	Dec. 5, 6-8	Williams	24-30	5	Whitish spot; no crater.
9	1868	May 1, 10-11	Williams	24-30	...	Whitish patch; line of interior shadow on the west.
10	1867	Oct. 7, $8\frac{1}{2}-10$	Williams	24-30	...	A very bright spot.
11	1867	Nov. 6, 8-10	Williams	30-36	6	A bright patch of light; streak of shadow scarcely discernible.
12	1868	April 2, 5-6	Williams	30-36	4	Whitish patch of light.
13	1868	April 2, $8\frac{1}{2}$	Birt	30-36	4	A very shallow crater, with interior shadow,
14	1867	Dec. 6, 9-10	Williams	36-42	5	Whitish spot; no crater.
15	1868	May 2, $6\frac{1}{2}-10$	Williams	36-42	...	Long patch of light to the E.
16	1868	May 4, $10\frac{1}{2}-11\frac{1}{2}$	Williams	48-54	...	Two bright spots.
17	1868	May 5, $10\frac{1}{2}-11\frac{1}{2}$	Williams	60-66	...	Two nearly equal and circular bright spots.
18	1868	May 6, $9\frac{3}{4}-10\frac{1}{4}$	Birt	72-78	...	Two bright spots.
19	1868	May 7, $11\frac{1}{4}-12$	Williams	83-85	...	Two bright spots, the east largest.

Evening illumination.

No.	Year.	Date, G.M.T.	Authority.	Sun's Alt.	Bright- ness.	Character.
20	1867	Nov. 15, 18-20	Williams	36-30	10°	Very bright.
21	1868	Feb. 12, $20\frac{1}{2}$	Williams	30-24	6, 4	Crater very conspicuous, with east peak very bright.
22	1867	Oct. 17, 13-15	Williams	30-24	...	Crater very conspicuous.
23	1867	Oct. 17, $13\frac{1}{2}$	Ingall	30-24	...	Drawn as a crater.
24	1867	Oct. 18, 17-19	Williams	18-12	...	Crater very conspicuous; small central cone casting a shadow.
25	1868	Jan. 15, $20\frac{1}{2}$	Williams	12-6	...	The crater conspicuous, with interior shadow on east fully equal to that of IV. A α^7 .

On certain partial Lunar Eclipses not noticed in the Nautical Almanac. By R. A. Proctor, B.A.

When there is a total or partial eclipse of the Moon by the Earth's umbra, the times of first and last contact with the penumbra are recorded in the *Nautical Almanac*. But when the Moon passes wholly or in part within the penumbra without

touching the umbra, no notice is taken of the phenomenon. This seems a defect, for the penumbral passages have now an evident value on account of the application of spectroscopic analysis. Also, there seems something defective in the theory of eclipses, as presented in works on Astronomy, in which, so far as I have seen, no notice whatever is taken of penumbral lunar eclipses. It may readily be shown that when these eclipses are taken into account, the total number of lunar eclipses in any long period slightly exceeds, instead of falling considerably short of, the number of solar eclipses.

It should be noticed that when a solar eclipse occurs alone—that is, without a lunar eclipse at the preceding or following full Moon—the Moon is always penumbrally eclipsed at one of these epochs, and more commonly at both of them. So that, when there are only two eclipses in the year—in which case both are solar—there are frequently *four* penumbral lunar eclipses, and there must be two such phenomena.

In the present year there are only two solar eclipses: one of these was annular and occurred in February, the other is the great total eclipse of August 17th next. The Moon will be penumbrally eclipsed both before and after the great eclipse. The former penumbral eclipse will not be visible in England; the latter I give the elements of this eclipse as deduced from an approximate calculation and projection:

Greenwich Mean Time of Opposition in R.A. Sept. 1				h	m	s
				14	54	0
Moon's Right Ascension				22	45	40.7
Moon's Declination				S. 9	11	13.7
Sun's Declination				N. 7	52	14.5
Moon's Hourly Motion in R.A.					28	55.5
Sun's Hourly Motion in R.A.					2	15.8
Moon's Hourly Motion in Decl.				N. 8	45.2	
Sun's Hourly Motion in Decl.				S.		54.8
Moon's Equatoreal Horizontal Parallax					54	11.4
Sun's Equatoreal Horizontal Parallax						8.9
Moon's True Semi-diameter					14	47.5
Sun's True Semi-diameter					15	53.8

These values, applied in the usual manner to the projection of the eclipse, give the following results:—

First Contact with the Penumbra, Sept. 1st	h	m
	14	16
Middle of the Eclipse	15	43
Last Contact with the Penumbra	17	10

Magnitude of the Penumbral Eclipse (Moon's Diameter = 1) 0.33

The first contact with the penumbra occurs at 11° 15' from the northernmost point of the Moon's limb towards the east.

The last contact at $44^{\circ} 20'$ towards the west.

At the time of central eclipse the penumbra intersects the Moon's limb at points $49^{\circ} 40'$ from the north towards the east, and 83° from the north towards the west. The middle of the shadow lies, therefore, $16^{\circ} 40'$ from the north point towards the west. (In all cases for direct image.)

I take this opportunity of remarking that, during a total lunar eclipse, a portion of the faint light still received from the Moon is probably due to the Sun's corona; and, therefore, the spectroscopic examination of the Moon at such a time might have interesting results. During some total eclipses the Moon has been wholly obliterated from view, even with telescopes having considerable light-gathering power. It might be interesting to inquire how far this peculiarity bears on our views respecting the corona.

I wish also to call the attention of observers of the Sun to the importance of carefully noting the appearance of the solar disk from the 14th to the 20th of August. The observers of the Great Eclipse on the 17th will, doubtless, record the exact positions of the rose-coloured prominences around the Sun's disk; and the comparison of such observations with the recorded positions and motions of solar spots and faculæ may possibly serve to exhibit some such association as has been suspected between the coloured prominences and the solar spots.

Minor Planet, (96) *Ægle*.

The following elements calculated from observations of 17 Feb., at Marseilles, and 1 and 14 March, at Leipzig, by Herr Vogel, are given *Ast. Nach.*, No. 1687.

1868, March 1·5, Berlin M.T.

$$\begin{array}{lcl} M = 346^{\circ} 34' 42'' \cdot 0 \\ \pi = 165^{\circ} 14' 32'' \cdot 7 \\ \Omega = 322^{\circ} 49' 25'' \cdot 9 \\ i = 16^{\circ} 5' 41'' \cdot 7 \\ \phi = 8^{\circ} 8' 16'' \cdot 8 \end{array} \left. \begin{array}{l} \\ \\ \\ \end{array} \right\} \begin{array}{l} \text{Mean Equin.} \\ 1868^{\circ} \cdot 0. \end{array}$$

$$\log \alpha = 0 \cdot 485130$$

$$\mu = 664'' \cdot 220.$$

Minor Planet, (97) *Clotho*.

The following elements, calculated by Dr. Maywald from Normal Places of March 1 and 30, and April 28, are given *Ast. Nach.*, No. 1696.

Epoch 1868, Jan. 0^o0, Berlin M.T.

$$\begin{aligned}
 M_0 &= 60^{\circ} 44' 22''.80 \\
 \lambda_0 &= 126 21 10.45 \\
 \omega + \Omega &= 65 36 47.65 \\
 \Omega &= 160 35 26.88 \\
 i &= 11 43 29.78 \\
 \phi &= 14 26 13.84 \\
 \log a &= 0.4258793 \\
 \mu &= 815''.0564.
 \end{aligned}$$

Minor Planet, (98) Ianche.

Discovered by Prof. C. H. F. Peters, Clinton, N.Y., on the 18 April. The following elements calculated by him from observations of April 18, 22, and 26, are given *Ast. Nach.*, No. 1695.

Epoch 1868, April 30^o0, Berlin M.T.

$$\begin{aligned}
 M_0 &= 6^{\circ} 18' 49''.8 \\
 \pi &= 180 59 48.0 \\
 \Omega &= 353 41 1.1 \\
 i &= 15 8 1.9 \\
 \phi &= 12 3 2.54 \\
 \mu &= 726''.603 \\
 \log a &= 0.4591396
 \end{aligned}
 \left. \begin{array}{l} \\ \\ \\ \end{array} \right\} \begin{array}{l} \text{Mean Equin.} \\ 1868.0. \end{array}$$

A telescope presented to the Society by Mr. Baker, Optician, High Holborn, was exhibited at the Meeting. The following is Mr. Baker's letter addressed to Mr. Huggins, Secretary of the Society:—

"I have recently come into possession of the earliest formed equatoreal instrument, which I believe to be one of three alluded to by Mr. Short in his letter to the Royal Society of Dec. 7, 1749 (see *Philosophical Transactions* of that year, p. 241). It consists of a Gregorian telescope mounted upon a universal stand, with hour and declination circles, and is, to all appearance, in its original state.

"It has occurred to me that this instrument would probably be acceptable to the Royal Astronomical Society, and would be deemed worthy of a place in their Museum of Instruments; if such should be the case, I shall have much pleasure in presenting it to the Society, and have forwarded it to their Apartments for the inspection of the Council."

It was, at the Meeting of the Council, resolved that the thanks of the Council be given to Mr. Baker for his valuable addition to the Society's collection of instruments.

Observations and Elements of Comet. By Dr. A. Winnecke.

The new Comet has been observed by me on every night since its discovery, June 13; the measures are the following:—

(Latitude $48^{\circ} 59' 44''$; Longitude $20^m 14^s$ West of Berlin.)

Karlsruhe																No. of			
M.T.																Comp.		Star.	
Comet—Star.																			
α Comet.																δ Comet.			
h m s																h m s			
1868.	h	m	s	m	s														
June 13	13	21	26	+0	30	80	-28	43	6	3	7	55	76	+47	18	29	7	4	b
13	14	15	42	-2	14	93	-	1	49	4	3	8	15	22	47	21	10	7	c
14	13	36	18	+0	31	82	+	0	43	2	3	15	6	58	48	20	28	9	d
15	14	25	54	+1	28	37	-	1	31	2	3	23	29	33	49	25	5	7	e
16	13	3	44	+0	26	17	+	1	47	0	3	32	12	67	50	24	57	8	f
17	11	34	42	+3	14	50	+	0	2	1	3	42	2	98	+51	24	36	7	g

Adopted Mean Places of Stars of Comparison, 1868.0.

	^h	^m	^s	[°]	[']	[″]	
<i>b</i>	$\alpha =$	3	7	25	05		$\delta = +47\ 47\ 25\cdot6$ Argel. vol. vi.
<i>c</i>		3	10	30	24		47 23 12 [·] 3 Radcliffe 922
<i>d</i>		3	14	34	83		48 19 57 [·] 1 Argel. Zone 64, No. 61
<i>e</i>		3	22	1	09		49 24 3 [·] 6 Argel. vol. vi.
<i>f</i>		3	31	46	50		50 23 10 [·] 8 Argel. Zone 71, No. 1
<i>g</i>		3	33	48	67		+50 24 47 [·] 1 Radcliffe 1066

The first comparison of the Comet was made with an anonymous star 9.10 mag., and therefore not yet reduced. The instrument used is a refractor of 5 inches aperture by Hertel and Reinfelder, at Munich, with ring micrometer.

From June 13, 15, 17, I have found the following elements of the orbit:—

$$\begin{aligned}
 T &= 1868, \text{ June } 25^{\circ} 93' 16'' \text{ Berl.} \\
 \pi &= 287 \quad 8 \quad 17.8 \\
 Q &= 53 \quad 18 \quad 48.6 \quad 1868.0 \\
 i &= 48 \quad 9 \quad 12.4 \\
 \log q &= .9765094
 \end{aligned}$$

Retrograde.

$$\text{Middle Observ. } (l' - o) \quad \Delta \lambda = +2''.2 \quad \Delta \beta = -2''.7$$

The splendour of the Comet increases rapidly; it is this night visible to the naked eye as a star of the 5th magnitude. The tail is 2 degrees long in the sweeper.

Karlsruhe, 1868, June 18.

The North German expedition for the observation of the Solar Eclipse of August 18 was to start from Berlin on the evening of Wednesday, July 8. The funds for this expedition are provided by the Norddeutscher Bundesrath, and it is understood that the general superintendence of the expedition rests with a resident Committee of the Astronomische Gesellschaft. The astronomers will land at Bombay, and will probably take a station considerably to the west of those taken by the British parties. In the selection of station, and in the arrangement of their journeys, they have been assisted by the advice of our best Indian scientific authorities.

The Editor has received from M. Hoek a list of Errata in the paper "On the Phenomena of Meteors : " this will be printed in the next Number.

ERRATUM.

P. 8, line 22, for *Uranus* read *Saturn*.

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